AD-A220 191

US Army Corps of Engineers
Nashville District

Cumberland River Basin
Remedial Construction
Wolf Creek Dam, Kentucky

Wolf Creek Dam Concrete Diaphragm Walls Final Completion Reports Phases I and II

December 1988

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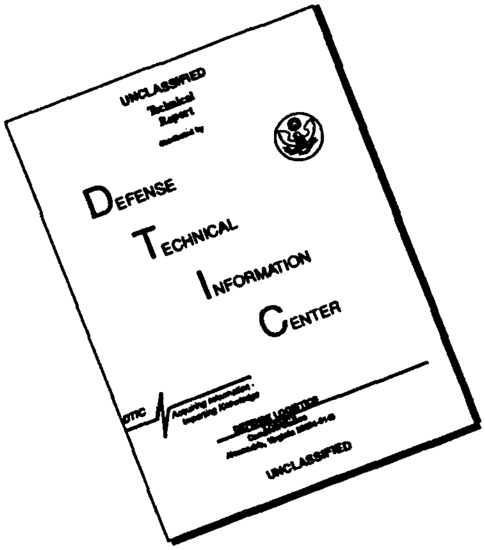

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DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
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NASHVILLE, TENNESSEE 37202-1070

IN REPLY REFER TO

30 MAR 90

CEORN-ED-G (1110-2-1906a)

MEMORANDUM FOR CDR, DTIC/DA-2, Cameron Station, Alexandria, VA 22314

SUBJECT: Wolf Creek Dam - Concrete Diaphragm Walls - Final Completion Reports, Phases I and II.

In accordance with ER 1110-1-1801, two copies of the subject reports are submitted for your disposal.

FOR THE COMMANDER:

for Phil Mitchell
R.J. CONNOR, P.E.
Chief, Engineering Division

Encls
as

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19. ABSTRACT *(Continue on reverse if necessary and identify by block number)* Severe foundation seepage problems led to the necessity of a permanent solution at Wolf Creek Dam after an emergency grouting problem was completed in 1972. A board of consultants was convened whose adopted recommendations were to install pile type concrete walls through the embankment of the dam and the area between the switch yard and the tailrace. Because the general nature of the work was relatively unknown to District personnel, and the extent of the specific scope of work was extreme even for experienced slurry wall contractors, a two-step bidding procedure was established and eventually awarded to ICOS Corporation of America. The construction was split into two phases, with approximately half the embankment wall and all of the switch yard wall in Phase I and the remainder in Phase II. The walls are comprised of 26 in. steelcased, tremie concreted caissons on 4.5 foot centers connected by concrete elements tremied through open excavation. All excavation was conducted through a full head at bentonite slurry. The wall reached a maximum depth of 278 foot. Construction was accomplished from 1975-80 under the administration of the Nashville District, Corps of Engineers. Wolf Creek Dam is located in Southcentral Kentucky.

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DA, Ohio River Division, Corps of Engineers, PO Box 1159, Cincinnati, OH 45201-1159 12 March 1990

FOR COMMANDER, NASHVILLE DISTRICT, ATTN: CEORN-ED-G

This office has no comment to subject reports.

FOR THE COMMANDER:

for Garrett P. Hammer

Encl
wd

RICHARD C. ARMSTRONG, P.E.
Director of Engineering

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20 JAN 1989

CEORN-ED-G

MEMORANDUM FOR: Commander, Ohio River Division, ATTN: CEORD-ED-G, P. O. Box 1159, Cincinnati, Ohio 45201-1159

SUBJECT: Final Completion Reports, Concrete Diaphragm Walls, Phases I and II, Cumberland River Basin, Remedial Construction, Wolf Creek Dam, Kentucky.

1. In accordance with ER 1110-2-1801, the subject reports are forwarded to your office for review. Three copies are enclosed.

FOR THE COMMANDER:

for Phil Mitchell
RICK CONNOR
Chief, Engineering Division

Enclosures
as

FINAL COMPLETION REPORTS
PHASES I AND II
WOLF CREEK DAM CONCRETE DIAPHRAGM WALLS

DECEMBER 1988

U.S. Army Corps of Engineers
Nashville District
P.O. Box 1070
Nashville, Tennessee 37202-1070

FINAL COMPLETION REPORTS
PHASES I AND II
WOLF CREEK DAM CONCRETE DIAPHRAGM WALLS

PHASE II COMPLETION REPORT

TABLES

FIGURES

APPENDICES

SUMMARY

Severe foundation seepage problems led to the necessity of a permanent solution at Wolf Creek Dam after an emergency grouting program was completed in 1972.

A board of consultants was convened whose adopted recommendations were to install pile type concrete walls through the embankment of the dam and the area between the switchyard and the tailrace.

Because the general nature of this work was relatively unknown to District personnel, and the extent of the specific scope of work was extreme even for experienced slurry wall contractors, a two-step bidding procedure was established and eventually awarded to ICOS Corporation of America. The construction was split into two phases, with approximately half of the embankment wall and all of the switchyard wall in Phase I, and the remainder of the embankment wall in Phase II. ICOS was also the low bidder for Phase II.

The walls were comprised of 26-inch steel cased, tremie concreted caissons on 4.5 foot centers connected by concrete elements tremied through open excavation. All excavation was conducted through a full head of bentonite stabilizing slurry. The wall reached a maximum depth of 278 feet.

The diaphragm wall construction was accomplished from 1975 through 1979, and site restoration completed in 1980, under the administration of the Nashville District, Corps of Engineers.

Both Phase I and Phase II contracts are covered in this report, with the Phase II report detailing only the changes in the contract and construction procedures from Phase I.

WOLF CREEK DAM REMEDIAL CONSTRUCTION
CONCRETE DIAPHRAGM WALL-PHASE I
COMPLETION REPORT

SECTION 1 - INTRODUCTION

1-01 Purpose and Scope. This report is presented to give a general discussion of the subject contract. It contains background and foundation information, details of the contract, general description of construction procedures, and discusses problems encountered.

1-02 General. High piezometric pressures developed in the earthen embankment at Wolf Creek Dam during the years following impoundment of the reservoir. The pressures, probably caused by an inferiorly constructed cutoff trench which was established in a highly solutioned limestone formation, caused piping of embankment and/or joint fill material. The first visual evidence of foundation distress which was construed to be of significance was noted in 1967 when a cluster of wet areas began to materialize at the downstream toe of the embankment and adjacent flood plain. Observation of muddy flows in the tailrace and the occurrence of sinkholes took place during the next 8 months. A review of original construction records revealed that a series of large solution channels existed upstream and downstream of the cutoff trench. It also revealed that there were areas where proper compaction could not have been achieved due to overhanging rock. Orientation of mapped features tended to align themselves with the distressed areas. It was also determined that rapid fluctuations of tailwater of up to 20 feet was a contributing factor in the deterioration of the dam due to headward erosion and pressure surging of cavernous areas. After expeditious exploration, a remedial grouting program was designed and initiated. Over 290,000 cubic feet of solids were eventually placed in bedrock, the overburden and the embankment. The grouting substantially lowered the hydrostatic head and arrested much of the piping. It has been postulated that this emergency treatment probably saved the project from experiencing a major failure.

The grouting, although effective, was not considered a permanent solution to the problem. Extensive studies and investigations were undertaken at the completion of the remedial grouting program to monitor the performance of the embankment, and to determine what measures should be taken to insure the integrity of the foundation of the dam. A board of consultants of internationally distinguished engineers and geologists from outside the Corps of Engineers, was convened in January, 1972. The three man board was composed of Mr. Francis B. Slichter, Civil Engineer; Dr. Ralph B. Peck, Civil Engineer; and the late Dr. Frank A. Nickell, Geologist. In July 1973, Mr George E. Bertram was retained as a consultant to review all data and submit an independent report. The board later expanded to include engineers Professor Ben C. Gerwick, Professor James M. Duncan, and Dr. Yves Pigeon and geologist Mr. Guy Laroque in 1974, and geologist Mr. John M. Kellberg in 1976. The original consultants' conclusions and recommendations were submitted in a report dated August 1972. The conclusions stated that serious defects existed in the foundation, that grouting could not be considered an

adequate permanent remedy for these defects, and that measures should be taken to insure the integrity of the foundation of the embankment. They recommended a positive cutoff in the karstic horizon of the Leipers formation be installed, beginning at the concrete structure, and extending about 2,000 feet landward. They also recommended suitable measures to protect the switchyard area from the 20-foot fluctuation of the powerhouse tailwater. An evaluation of known possible permanent solutions to the foundation problem at Wolf Creek Dam indicated that the most economical and reliable engineering solution was a concrete cutoff wall composed of pile-type elements along the upstream embankment crest. The wall would extend from the top of the dam to the base of all known solution activity. A similar cutoff wall was devised to protect the downstream toe of the embankment and the switchyard area. The more established industry-wide procedure of panel wall construction was rejected for safety considerations. An expedited two-step bidding procedure (see section 3-01) was initiated with ICOS of America, Inc., obtaining the contract with their diaphragm wall concept. Construction began in August of 1975.

1-03 Authorization and Appropriation. Original design and construction of the Wolf Creek project was authorized by the Flood Control Act of 1938 (Public Law no. 761, 75th Congress, 3rd Session) and the River and Harbor Act of 1946, (Public Law 525, 79th Congress, 2nd Session). The concrete diaphragm wall construction was financed through general construction funds, first appropriation 26 April, 1974, appropriation code 21X3113, Flood Control, General.

1-04 Project Location and Description. Wolf Creek Dam is located in Russell County in South-Central Kentucky on the Cumberland River, 460.9 miles above its confluence with the Ohio River. The damsite is approximately 10 miles southwest of Jamestown, Kentucky, and about 12 miles north of Albany, Kentucky, on U.S. Route 127. The dam and reservoir locations are shown on plate 1.

The dam is a combination concrete gravity and rolled-fill earth embankment structure 5,736 feet in length and with a maximum height of 258 feet. The concrete section of the dam is 1,796 feet in length and is made up of a gated spillway section, a power intake section serving six power units, a short left bank nonoverflow section, and a right nonoverflow section embedded in the embankment. The embankment is homogeneous rolled fill 3,940 feet in length. Net head during power generation averages 170 feet. The total capacity of the reservoir below top of power pool is 3,995,000 acre-feet and below spillway crest 6,000,089 acre-feet, making the reservoir the largest man made lake east of the Mississippi River.

Construction of the dam began in August of 1941 and was discontinued in August of 1943 in the interest of World War II. Construction was resumed in September, 1946 and was completed in August, 1951.

1-05 References and Related Material. Background for this report and other information concerning the history of Wolf Creek Dam can be found in material listed in "References and Related Reading".

SECTION 2 - FOUNDATION

2-01 Site Geology. The Cumberland valley is a broad, deep entrenchment cut in nearly level argillaceous or shaly limestones and shales approximately 500 feet below the surrounding ridge tops. These beds dip upstream approximately 30 feet per mile. The formations related to the construction of the dam are, in ascending order, the Catheys, Leipers, and Cumberland of Ordovician age, the Chattanooga of Devonian age, and the Ft. Payne of Mississippian age. See Figure 2-1 for generalized geologic section. These formations are described below.

The 120 feet of the argillaceous limestones and thin interbeds of calcareous shales of the Catheys Formation are very similar to those of the overlying Leipers Formation. In fact, separation of these two formations without the aid of fossils is so difficult that they were grouped together for the geologic studies. Both the Catheys and the Leipers that form the valley floor are quite susceptible to solutioning by groundwater, particularly along the joints or fractures that act as paths for the groundwater movement.

Overlying the 110 foot thickness of the Leipers Formation is the sandy to argillaceous limestone of the Cumberland Formation. Although the thickness of this limestone is variable, it has a maximum thickness of 41 feet in the dam area and occurs in the right abutment between elevations 630 and 655.

Above the Cumberland Formation in ascending order are the Chattanooga and Fort Payne Formations. In the right abutment the Chattanooga shale occurs between elevation 655 and 689 and averages 34 feet in thickness. The shale is typically black, hard and carbonaceous with occasional nodules of iron sulphide. The Fort Payne consists of argillaceous limestone and dark carbonaceous shale. In the right abutment the Fort Payne generally occurs above elevation 689 and has a minimum thickness of 70 feet.

The alluvial overburden materials of the valley bottom, ranging from 2 feet up to 40 feet in thickness, consist of stratified silts, clays, and sand, with minor amounts of gravel.

In general, the bedrock-overburden contact is well defined, and the bedrock is free from faulting and severe folding (there is gentle warping of the bedrock throughout the area). Although structurally insignificant, as far as geology is concerned, the jointing did control the direction of leakage through the bedrock. Major joint trends are regional rather than local, and the predominant sets of joints run parallel and normal to the axis of the dam. Solutioning of the bedrock is more prevalent where regional jointing is augmented by local minor jointing which was possibly caused buy the slight local variations in direction and degree of the dip of the beds. The areas having the most intensive solutioning correspond roughly to the areas having the most variation in degree and orientation of jointing.

Numerous solution channels, caves, and small tunnels were uncovered during the excavation of the cutoff trench. Most of these rock channels and caves had a marked parallelism of their walls which trended in one of two directions nearly parallel to or normal to the dam axis, clearly

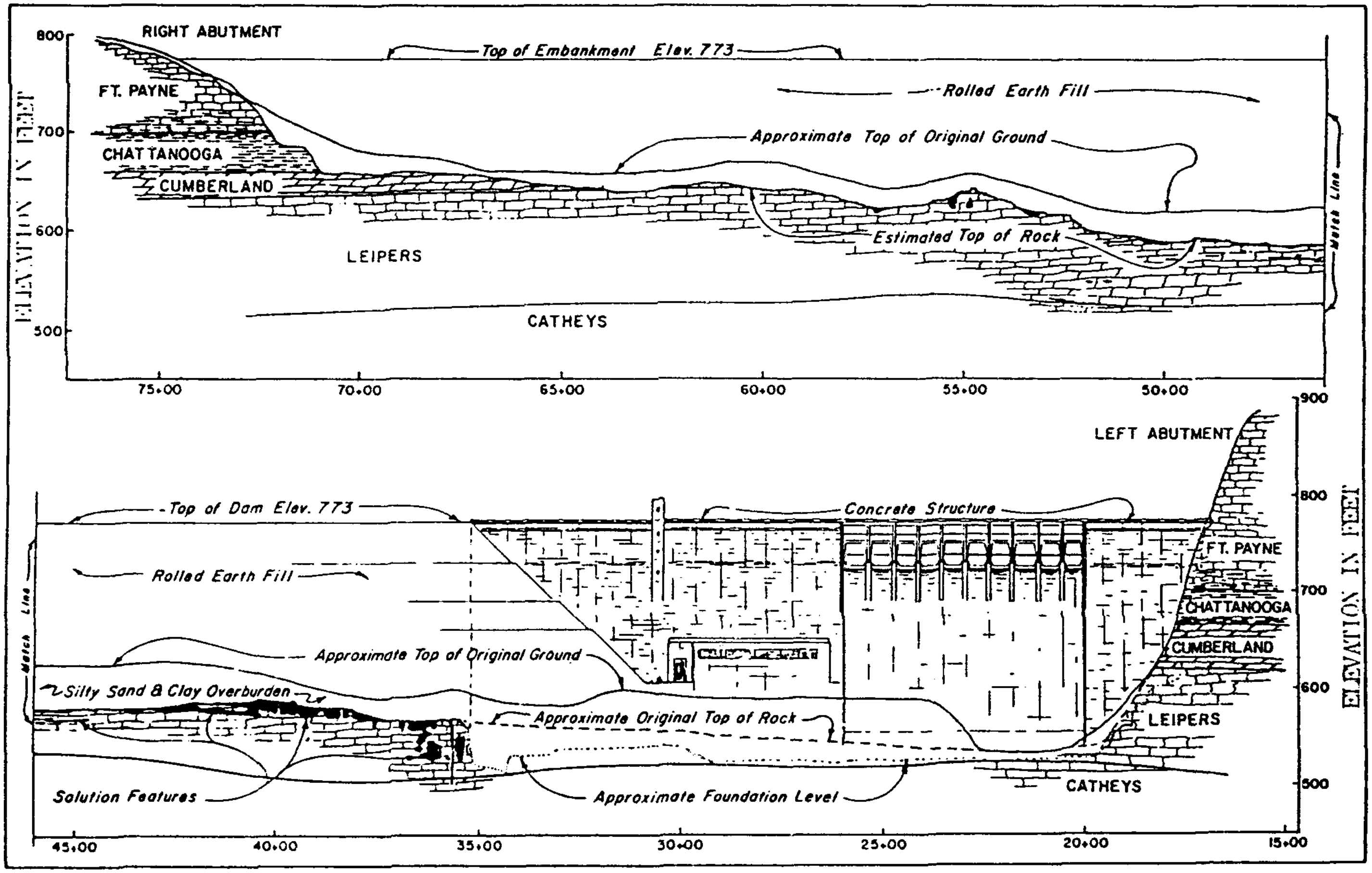


FIGURE 2-1. Geologic section of Wolf Creek Damsite.

indicating that they were a result of solutioning along the joint planes. Although there were several unfilled "small tunnels," caves were generally filled with stratified clayey silt. The fill is not impervious and is subject to removal by desilting under seepage gradients. The solutioning was predominately confined to the rock above elevation 525, and there was little evidence of solutioning below elevation 500.

For an excellent treatise on the evolution of the geology of the area, see Reference 4,"Geology of the Cumberland River Basin and the Wolf Creek Damsite, Kentucky".

2-02 Embankment Design. The embankment section of Wolf Creek Dam was designed as a homogenous rolled-fill embankment 3,940 feet in length extending from the concrete section at station 35+11L to the right abutment at station 74+51L.

The foundation of the embankment generally was the stratified alluvial overburden overlying solutioned limestone bedrock. This overburden consisted of a top impervious layer averaging 20 feet in thickness and overlying a more pervious layer averaging 20 feet also. Both overlie more pervious layers of silty sand and sands and gravels extending to top of rock. The overburden was excavated to top of rock in areas adjacent to the concrete section and along the cutoff trench. In the remainder of the embankment foundation area, the overburden was stripped to a depth of approximately one foot except where soft organic soil was encountered and removed. A two foot thick sand and gravel blanket to facilitate drainage from embankment drain holes and to aid consolidation is located between stations 40+00L and 60+00L. The degree of solutioning of the limestone bedrock varies considerably from deep cavernous solutioning to shallow solution channels along top of rock, and was generally limited in extent.

An impervious fill cutoff trench with a minimum 10-foot wide bottom extends from the right abutment at embankment station 74+30L to station 72+49L following the centerline of the embankment. The trench then curves upstream and continues approximately parallel to the embankment centerline. At approximately station 39+00L the trench curves to tie in with the concrete dam. A single line grout curtain was installed, usually to a depth of 50 feet, generally on 10-foot centers, below the cutoff trench bottom.

2-03 Investigations Prior to Concrete Diaphragm Wall Construction. Drill crews were mobilized after the first sink hole developed in the wet areas below the dam in August, 1967. Six drive samples and three auger borings were made in the area. Among other findings, it was noted that water stood at the surface of the sample holes.

Divers were brought to the site to investigate the muddy flow observed in the tailrace in October, 1967. Three openings in the rock were found from which muddy water was flowing.

After a second sinkhole was discovered near the switchyard on 13 March, 1968, the District ordered a study of the foundation design to include an analysis of joint pattern orientation in order to correlate the sinkhole with the mud in the tailrace. Split spoon drive sampling

was initiated on the following day. The information collected indicated that the seepage was occurring around the masonry section through or immediately above the foundation bedrock. Piezometers were installed and core drills were brought in to sample the rock within the sinkholes. A solution channel was discovered, connecting the sinkholes with the tailrace. Dye testing revealed a seepage in the solution channel of 0.3 feet per second.

Temperature testing was initiated which showed a lower than normal thermal condition, indicating a direct connection with the cooler water of the lower levels of the reservoir. Piezometric contours revealed steep gradients from the sink area to the centerline of the embankment. A third sinkhole was discovered on 22 April, 1968.

In the period following the report of the first sinkhole, all previously collected information, along with that being rapidly developed from the expedited field work, was continuously being studied and evaluated. By 1 April, 1968, it was generally concluded that seepage was passing either under or through the cut-off trench or both, then down through a solution system in bedrock which drained toward the tailrace and under the sinkhole area.

A study of the original construction techniques used showed a deficient cutoff trench in both size and compaction. The subadequate trench, along with probable holes in the grout curtain, allowed reservoir water to move through caves and solution channels of the foundation rock, eroding or piping the filling material out of the cavities. The presence of these openings together with normal embankment seepage caused portions of the earth embankment to be piped away. Movement of materials from the downstream side also resulted from the fluctuations in the tailwater level. Rapid changes of approximately 20 feet in the tailwater were caused by the generating operations. As a consequence, a flushing or surging action of the tailwater resulted in headward erosion of materials in the solution channels.

In January, 1973, subsurface exploration was initiated along the axis of the embankment to determine conditions along the potential alignment of the diaphragm wall. These explorations include core borings on 3.12 foot centers from stations 37+50L to 58+00L and thence on 6.25 foot centers landward. The holes were cored in rock to well below all karstic formations to approximately elevation 475. In the switchyard, the rock along the proposed wall was also explored, here to approximately elevation 500. Solution features in the rock formations were well mapped in this phase. Also discovered were areas of very soft overburden near top of rock. These were designated as "soft zones".

Various geophysical logging devices were used in this phase of exploration, some of which were SP- resistivity, natural gamma, caliper, temperature, short and long normal resistivity, lateral, televiewer, 3-D velocity, acoustic, and directional.

For a detailed study of the events and investigations leading up to the actual construction of the concrete diaphragm wall, including graphic representations of the various tests made, cross sections derived from core samples, and maps depicting locations of subsurface phenomena, test sites, instrumentation, etc., see References 5 and 10, "Analysis and Evaluation of Safety of Earth Embankment", and "Remedial Treatment Exploration, Wolf Creek Dam, Ky."

2-04 Investigations During Construction. Due to the nature of this project, most of the Quality Control and Quality Assurance dealt with foundation investigations. Therefore, this topic will be discussed under the more suitable subheading "Construction".

SECTION 3 - CONTRACT

3-01 Two Step Bidding. Since concrete diaphragm wall construction was relatively unknown in the U.S. in 1974, and due to the depth needed and possible hazards associated with working with full reservoir head in solutioned limestone, the Corps did not feel competent to assemble an original design. The two step bidding approach was chosen for the project, requiring an approved original technical proposal before formal bidding would be allowed.

A request for technical proposals from the construction industry was issued by the Corps of Engineers in May of 1974. This was the first of a two-step formal advertising procedure which eventually resulted in the concrete diaphragm wall construction. This two-step procedure was selected to survey and evaluate different construction firms' methods and techniques prior to the actual bidding. Evaluation by the Corps of Engineers and the Board of Consultants determined the acceptability of the construction firms' meeting the requirements set forth in the request for the technical proposals. Technical proposals were received from seven construction companies. During the Board of Consultants meeting of 3 and 4 December 1974, it was agreed to reject five of the technical proposals and to request clarifying information from the two remaining firms. Late in March 1975, the firms of ICOS Corporation of America of New York, New York and ECI-Soletanche of Pittsburgh, Pennsylvania were notified of the acceptance of their proposals. The two acceptable contractors were invited to proceed under step two and submit bids for the construction of the diaphragm wall.

3-02 Plans and Specifications. Plans and specifications, contract number DACW 62-75-B-0036, were prepared for each accepted technical proposal, under the direction of the District Engineer, Nashville District, and are on file at the office of the District Engineer.

3-03 Award. The Phase I contract was awarded to ICOS Corporation of America on 27 June, 1975. The original contract amount was $49,959,900.00 and had a completion date of 24 April, 1978. ECI-Soletanche turned in a bid of $69,940,500.00. (The government estimate was $40,400,000.00, without profit.) The Notice to Proceed on Contract No. DACW62-75-C-0206 was signed by ICOS on 8 August, 1975. Mobilization to the site began immediately.

3-04 Modifications. 21 modifications were written during the course of the contract. They resulted in an overall increase in

$106,040.48 and 107 calendar days to the contract amount. The modifications are listed in Table 3-1.

TABLE 3-1
CONTRACT MODIFICATIONS

Mod.No.	Date	Description	Change to Contract
P00001	30 Mar.1976	Revised the alignment of the concrete diaphragm wall	None
P00002	01 Jun.1976	Modified the core storage warehousing and racks by adding core storage racks, a work table and lights.	Added $8,237.87
P00003	26 Oct.1976	Extended the contract completion date due to strikes.	18 cal. days
P00004	12 Oct.1976	Extended the contract due to labor disputes at the casing fabricator's plant.	9 cal. days
P00005	22 Oct.1976	Authorized tests to be performed on the sheet pile wall anchors at the working platform to analyze the actual stresses developed in the anchor bars.	Added $26,400.00
P00006	21 Dec.1976	Constructed an 8-ft. high chain link security fence around the perimeter of the working platform.	Added $21,100.00
P00007	14 Apr.1977	Credit for use of nondomestic steel pipe for permanent casing. Waver obtained from Secretary of Army from Buy American Act. ICOS inadvertently purchased nondomestic steel pipe to be used as permanent casing.	Credit of $282,000.00
P00008	24 Apr.1977	Extended contract completion date due to abnormal weather.	18 cal.days
P00009	02 Jun.1977	Widen the existing powerhouse and Resident Engineer's roadways.	Added $24,836.00
P00010	13 Aug.1977	Furnish and install a system of continuous recording piezometers to monitor the effect of drilling operations on the water in the bedrock cavities.	Added $222,895.65

P00011	28 Oct.1977	Constructed a 20-ft. extension for the existing core storage building and included 4 additional core storage racks.	Added $23,702.70
P00012	24 Jan.1978	Provided an 8-inch tremie pipe with a fabricated tremie hopper for the placement of tremie concrete in the diaphragm wall.	Added $33,183.12
P00013	30 Dec.1977	Repaired the access roadway to the Resident Engineer's facilities by removing an existing 18 inch culvert pipe and installing a 24 inch culvert pipe.	Added $2,500.00
P00014	10 Jan.1978	Constructed 2 temporary stairways to provide access from the top of the work platform to the upstream and downstream slopes of the dam.	Added $16,543.76
P00015	21 Mar.1978	Accelerated construction of elements S-170, S-176, and S-180.	Added $25,242.10
P00016	27 Mar.1978	Extended the completion date for removal of Phase I platform to coincide with the completion of Phase II. Released 25% of mobilization and demobilization bid item to be upon *substantial* completion, instead of at the completion of Phase I work.	See description.
P00017	23 May 1978	Permitted the contractor to use an air lift drilling method in lieu of the direct circulation drilling originally specified.	Decreased $75,000.000
P00018	12 Jul.1978	Replaced the existing guardrail with new guardrail, in the Phase I limits, to meet existing Kentucky specifications.	Added $31,600.00
P00019	21 Jul.1978	Resurfaced the No. 2 Dam Adit Road in conjunction with the work in the switchyard.	Added $14,994.78 & 3 cal. days
P00020	02 Aug.1978	Extended contract completion date due to abnormal weather and strikes.	52 cal. days

P00021	12 Jul.1979	Variations in Estimated Quantities in the contract. New Items Nos. 31 and 32 were established and set up lump sum payments for an overrun in test drilling and recovery of fixed costs for items not used.	Decreased $38,195.50
P00022	Apr.1981	Set up Item No. 33, a lump sum payment to cover underruns in Items 13 and 14, Bedding and Riprap.	Added $50,000.000

3-05 Labor Relations. The contractor and subcontractors met or exceeded the minimum wages as determined by the Secretary of Labor in the labor standards provisions for each craft for Russell County, Kentucky.

ICOS utilized union labor for all contract work. There were several minor labor disputes which resulted in work stoppages during the contract time. The strike of the longest duration, June 14 through June 28, 1976, was precipitated when several crafts' union contract expired simultaneously state wide.

3-06 Government Furnished Property. No property was furnished to the contractor by the government for this contract.

3-07 Safety. ICOS Corporation submitted their safety plan and job hazard analysis during mobilization. The plans were reviewed and accepted by field and District Office personnel. ICOS held weekly "tool box" safety meetings for field personnel and monthly supervisors' meetings for all the supervisory staff, including subcontractors.

In March of 1979 the Associated General Contractors of America presented to ICOS a Merit Award for Accident Prevention in the Heavy Construction Division and a Certificate of Commendation for over 50,000 manhours worked through the year ending 31 December, 1978 with no disabling injuries. The Resident Engineer's staff and ICOS supervisory personnel worked diligently to establish and to maintain a good safety record. This effort yielded results as throughout the extended life of this contract the most severe accidents were of the broken-bone variety. There were only 12 lost time mishaps (both phases I and II) totalling 92 working days lost, while a total of over 1.5 million man hours were worked.

3-08 Subcontractors. Table 3-2 lists the subcontractors used by ICOS, and the phase of work for which they were responsible.

TABLE 3-2
SUBCONTRACTORS

Subcontractor	Address	Responsibility
John Bouchard and Sons Co.	1024 Harrison St. Nashville, Tn. 37202	Heating and Plumbing
Art's Electric	411 Holmes St. Frankfort, Ky. 40601	Electrical
Ambrosius Erecting Corp.	P.O.Box 13118 Louisville, Ky. 40213	Construct welding shop
Metal Products Division Armco Steel Corp.	P.O. Box 49525 Atlanta, Ga. 30329	Metal buildings
Wehr Constructors, Inc.	2127 South Floyd Ave. Louisville, Ky. 40210	General Construction
C&S Electric	S. Hwy. 127 Somerset, Ky.	Electrical maintenance
Vernon M. Williams and Sons Const., Inc.	1402 Lebanon Rd. Nashville, Tn. 37210	Core storage building
R. E. Gaddie, Inc.	P.O. Box 300 Bowling Green, Ky. 42101	Paving and stone
E. Randle Co.	P.O. Box 396 Frankfort, Ky. 40601	Work platform construction
Valley Fence Co., Inc.	P.O. Box 10128 Louisville, Ky. 40210	Fencing
Southern Fence and Land-scaping, Inc.	208 W. Dishman Lane Bowling Green, Ky. 42101	Fencing
Drillers/Kentucky Ltd.	4635 S.W. Freeway Suite 620 Houston, Tx. 77027	Rock drilling
Geotek Engineering Company	612 West Iris Drive Nashville, Tn. 37204	Core drilling, Annular space grout
Arthur C. Harpring, Inc.	988 Swan Louisville, Ky.	Guardrail

Appollo Erection Co.	Nashville, Tn.	Steel for core storage building
WCW Electric Co., Inc.	1207 Whites Creek Pike Nashville, Tn.	Electrical
Lowhorn Construction Co., Inc.	U.S. Hwy 127 North Albany, Ky.	General
Harrod-Carter, Inc.	P.O. Box 794 Frankfort, Ky. 40601	Concrete

SECTION 4 - CONSTRUCTION

4-01 General. The preconstruction conference for the contract was held in Nashville, Tennessee on 5 August, 1975. Contract administrative policies, contractor's safety plan, job hazard analysis, quality control plan, environmental control plan and the labor standards program were discussed. Also, a general discussion of the contract work was held there before the conference closed.

The notice to proceed was signed on 8 August, 1975, and mobilization was immediately begun. The contractor's first operation was the construction of their shop and office complex at the damsite (see Appendix A, Plate A-2 for layout). They also began placing orders for their specialty type equipment from locations around the world. Because of the unique nature of this contract, much of the equipment and materials used were of special order and of ICOS' own design.

4-02 Contractor's Organization. Construction began under the general supervision of Mr. Fernando Golini as project manager. Mr. Al Messina became the Project Manager in January, 1976 and served in that capacity until June of that year when he was relieved by Mr. Antonio Paveglio. Mr Golini became the assistant to Mr. Paveglio and the pair remained in charge until the completion of the contract.

The contractor's employment force reached a maximum of 208 employees in June of 1977 and averaged approximately 175 employees throughout the contract working periods. ICOS utilized a number of "specialists", company personnel from the home office in Milan, Italy, or from one of several international offices.

4-03 Contractors' Plant and Equipment. ICOS utilized several pieces of specialized equipment for the contract work. These machines were specially designed and fabricated by company personnel and/or specially modified for use at the Wolf Creek project. The Casagrande casing driver, the Wolf Creek rigs and the Hong Kong rigs were three such types of equipment.

The Casagrande casing driver was an elaborate hydraulic jacking

system. A diesel engine actuated a hydraulic system of four- 200 ton hydraulic rams. These rams moved a casing holding mechanism (actually hydraulically actuated jaws) bidirectionally-vertically and rotationally. This equipment was used to advance and pull 47 and 41 inch temporary casing used in the embankment and overburden excavation. See photographs 20 and 21.

The Wolf Creek rig was a small track-driven, highly maneuverable mini-crane used to excavate the secondary elements. It operated with a very quick tempo by means of a mechanically activated (brake and clutch) two cable system for clam bucket and chisel excavation. See photographs 51 and 53.

The Hong Kong rig was a hydraulic drill capable of drilling large diameter holes. It was assembled by ICOS for a project in Hong Kong, and required only slight modification for use at Wolf Creek. This piece of equipment is shown in photograph 27. The subcontractor, Drillers/KentuckyLtd., also utilized a similar drill for its portion of the contract (see phptograph 28).

Table 4-1 includes all the major plant and equipment used during the project by ICOS and the major subcontractors.

TABLE 4-1
CONTRACTORS' PLANT AND EQUIPMENT

ICOS	
2-100 ton LinkBelt cranes	1-Bentonite mixing plant
1-80 ton LinkBelt crane	2-6"Electric submersible pumps
4-45 ton LinkBelt cranes	1-8"Electric pump
1-35 ton Hydra-crane	1-4"Midwhirl diesel pump
1-18 ton Hydra-crane	4-Desanders (Shale shakers with hydrocyclones)
7-Wolf Creek rigs	5-Casing drivers
3-Load Lugger trucks	1-10 ton gantry crane
1-Flat-bed truck with Pitman Hydra-lift	Claw buckets
1-680 Case backhoe	Chisels
1-600 CFM compressor	Shop equipment
1-750 CFM compressor	Temporary casing, 47"dia., 41 1/4"dia., 36" dia.
1-185 CFM compressor	1-Pipe trailer
2-Generators - 60kw, 105kw	Pickup trucks
4-Light plants	
1-TD-15 dozer	
1-Fuel truck	
HARROD-CARTER	
1-Rex concrete plant	4-Mack mixer trucks
1-55 Michigan loader	
GEOTECH ENGINEERING CO.	
1-Mobile B-53 drill, truck mounted	2-Grout plants
1-Pickup truck	

DRILLERS/KENTUCKY, LTD.,

1-Hughes 820 shaft drill
1-Winch truck
1-Pickup truck
1-750 CFM compressor
1-Pickup truck
1-Shale shaker

E. RANDLE CO.

1-670 Loraine 70 ton crane
1-Cat 12F grader
1-Koehring backhoe (track)
1-K13 Kobe diesel pile hammer
1-Cat D-3 dozer
2-Cat 977 loaders
1-Flat bed trailer
1-30B Buchyrus-Erie 60 ton crane
1-Pitman hydralift with truck
1-580 B Case backhoe
1-Cat D-6 dozer
1-1 ton truck

The concrete subcontractor, Harrod-Carter, erected a concrete batching plant which satisfied all aspects of the specifications. It was located approximately one mile south of the dam. The plant was a fully automatic, low profile, Model 40 Rex Transmix with a special pozzolan handling and weighing system. The plant system components consisted of the following items which were sized to provide a batching capacity of up to 300 cubic yards per hour. The plant had sufficient storage capacities of each material to batch out 120 cubic yards without the need for refilling. The aggregate bins, automatic batching system, digital recording system, water, and admixture systems were enclosed in a heated building to insure production and delivery of specification concrete in cold weather.

The aggregate section consisted of a 250 ton, CPBM rated, 3 compartment bin. Each compartment had one high level motorized paddle type bin level signal. The aggregate batcher had a 12 cubic yard capacity, was CPBM rated, with a 4800 pounds by 40 pounds dial scale with 1200 graduations. The batcher had baffles to aid in blending. The gate was air operated, solenoid controlled, and was factory programmed to close in event of a power failure. Dial-a-Width actuators were installed on the gate to allow the operator to set the first stage of the automatic two stage opening at any desired position remotely from the control panel and to vary the gate opening during discharge. The bin charging system had a 30 inch by 149 inch radial stocker rated at 300 tons per hour with a 10 foot by 10 foot hopper to be charged by front end loader.

On site aggregate storage consisted of two 500 ton concrete bunkers (one for sand, and one for the 3/4" coarse aggregate).

The concrete bin had a 750 barrel capacity and was divided into two compartments. One compartment was used to store type I cement and the other for type II. The batcher had a 12 cubic foot CPMB rated capacity with a 9600 pound by 7.5 pound dial scale having 1200 graduations. It included an air operated, solenoid controlled discharge gate, inspection hatch, test overload drain spigot, automatic discharge aeration system and low noise vibrator. Dial-a-Width actuators were installed on the

gate to allow the operator to set the first stage of the automatic two stage gate opening to any desired position remotely from the central panel and to vary the gate opening during discharge.

The fly ash batching system was a Perry Todd Fly Ash Pneumatic Batch. It had a 360 barrel storage bin and a 20 cubic foot pressurized batch hopper which pneumatically transferred the material to a batcher mounted on a scale frame in the cement batch module. It had a dial scale with 2400 pounds by 2 pounds (1200 graduations).

The batching plant conveyor belt was 30 inches wide by 45 feet long with a 20 horsepower motor and shaft mounted reducer sized for 350 feet per minute belt speed. A combination aggregate and cement collecting hopper which also had a water ring around its perimeter and separate boots for cement and aggregate was mounted at the head end for changing mixer trucks.

The water for mixing and washing purposes was pumped from a well located beneath the batch plant building by a submersible pump into a 15,000 gallon storage tank. The water was metered by a 3 inch Badger turbine type water meter with and electric impulse generator to provide one digital readout per gallon. It had a capacity of 300 gallons per minute.

The air system consisted of separate high and low pressure subsystems. The low air pressure system consisted of a high volume (125 CFM) low pressure Roots type blower. The high pressure system consisted of a 10 horsepower, two stage, constant running compressor with built-in constant pressure by-pass system.

The batching control panel was a Rex Model 214 MDPunch Card control panel with a capability of weighing cement, fly ash and three aggregates. It had batch size selector weights, metered water control with digital readout in gallons, slump adjust control, Rex IMC moisture meter, moisture compensator (adds sand, deducts water), weighing sequence for visual check of batching process, and complete electrical interlocks for automatic batching system.

A digital recorder recorded the following information on a ticket:

Time
Date
Year
Batch Count
Formula No.
Truck No.
Weight of each aggregate (Accumulative)
Weight of Cement
Weight of Fly Ash
Vol. of Water
Vol. of Two Admixes (A.E.A. and Pozzolith

Concrete materials, mix design, placing procedures, and problems will be discussed later in the report.

4-04 <u>E.P.A. Restrictions and Disposal Areas.</u> The contractor's

submittal for waste disposal was approved upon the securing of a construction permit for his bentonite treatment plant from the Kentucky Department for Natural Resources and Environmental Protection.

The waste (used bentonite fluid) was carried from the work platform by a system of pipes to the bentonite treatment plant located just downstream of the powerhouse road. Here a 10% solution of aluminum sulfate was added to the waste slurry just prior to its reaching the first of three settling tanks. With the addition of this coagulant, the solid particles from the excavation process and the bentonite separated, leaving the water to pass through the two additional settling tanks before flowing into a drainage ditch. A flow monitoring meter (Stevens Model 61R) with a continuous recorder was installed in the flume to gage the effluent quantity.

The sludge was removed from the settling tanks by pumping it into mixer trucks, hauled to the concrete plant where sufficient cement was added to it to achieve a minimum of 25 psi unconfined compressive strength. The heavier or partially set sludge was periodically removed by backhoe, and mixed with solid material from excavation in the disposal area. The treated sludge was held in trenches within the confines of the designated spoil area in the pine forest immediately downstream of the dam. Once set, the wasted sludge was covered with solid material from the diaphragm wall excavation.

In compliance with other E.P.A. and Corps of Engineers Regulations, the contractor utilized both a water truck and a chemical additive to control dust around their work shops and on the haul roads. An oil absorbent was immediately applied to any oil spillage throughout the contractor's work area. The project's layout and temporary construction facilities were well planned and managed by both the government and the contractor, thus making compliance with E.P.A. regulations fundamental and easily obtainable.

4-05 Diaphragm Wall Construction Procedures.

4-05.1 General. The contract called for the construction of two positive cutoff curtains comprised of small interlocking elements created from slurry wall excavation/tremie concrete method, one through the embankment along the centerline of the dam, and the other between the tailrace and the switchyard. (For location see Appendix A, Plate A-3). Both walls extend well into bedrock beneath the embankment to predetermined depths. The embankment wall along the axis was tied into the concrete of the dam while the switchyard wall was tied into the concrete of the powerhouse. The embankment wall was offset in the embedded tailtower area a maximum 16.9 feet upstream to avoid that structure. Restrictions were placed on the size of the area permitted to be opened at one time, thus limiting the contractor to excavating a single hole within a given reach along the alignment of the curtain.

4-05.2 Work Platform. For the embankment wall, the crest width of the dam had to be widened to accommodate the detour of U.S. Highway 127 which crosses the dam, and to provide working space for the contractors' equipment. The width was increased from the original 33 feet to a maximum 150 feet utilizing sheet piling and gravel backfill.

The piling were driven into the dam embankment and tied back to a buried concrete anchor wall. Approximately 92,000 cubic yards of limestone gravel was hauled from local quarries to provide backfill. The surface was paved with concrete in areas of high density heavy equipment operations and with asphalt in the remaining areas to facilitate the general construction functions. U.S. Highway 127 was detoured around the work area on the upstream side of the platform and restricted to one lane passage which was controlled by automatic traffic signals. Surface runoff was contained in half-round metal trenches running parallel with the axis and carried off by a drainage system piping away from the dam embankment. (See Appendix A, Plate A-2 for layout of work platform and photograph 5 for drainage.)

4-05.3 Guidewalls. Two parallel 4 foot by 7 foot steel reinforced concrete guidewalls were constructed as templates for wall alignment. They also served to contain an excess of slurry and to keep the tops of the excavations from sloughing back. Details of the wall can be found in Appendix A. Also see photographs6, 7, and 8.

4-05.4 Layout. See Appendix A, Plates A-5, A-7, A-12 and A-13 for the orientation of the sequencing and dimensions of the interlocking elements. Surveyed monumentation for primary elements were placed in each guidewall on 4.5 foot longitudinal spacing, allowing the center of each to be found by using only a straight edge and rule. Secondary elements are the wall segments constructed between two consecutive primary elements. The elements were numbered in sequence beginning with P-101, S-102, ... from the tie-in with the concrete portion of the dam, toward the right abutment and in the switchyard SP-101, SS-102, ... from the tie-in with the powerhouse.

4-05.5 Element Installation Procedures.

4-05.5.1 General. Procedural order of primary element construction was: overburden excavation, rock excavation, core drilling, permanent casing installation, and tremie concrete. Procedural order of secondary element construction was: Overburden excavation, rock excavation, and tremie concrete. All phases of work were under strict quality control and assurance programs, especially with regard to the safety of the embankment, with continuous monitoring of excavation rates, monitoring slurry levels and control of slurry properties, logging and testing excavated materials, monitoring the various types of instrumentation, and adhering to verticality requirements. Refer to figures 4-1 through 4-3 while following the construction sequences outlined below.

4-05.5.2 Investigations and Controls During Construction. The concrete diaphragm wall was composed of two types of elements which interlocked to form the continuous structure. The elements were designated as primaries and secondaries. Two phases of investigation were conducted by construction personnel on all primaries and one on all secondaries. The first phase entailed constant monitoring of excavated materials, and bentonite slurry (drilling mud)

analysis. The slurry level in the excavations were periodically checked for leakage detection and the fluid was periodically tested for density, sand content, and pH, for safety and stability of the excavated element walls. The second phase of investigation, concerning primary elements only, called for a core boring with pressure testing and pressure grouting to a specified elevation below the bottom of the elements to insure that the completed wall segment was founded in sound bedrock. In addition, Foundations and Materials Branch, Nashville District, monitored piezometric, inclinometer, and monumentation data with continuing excavation.

In materials monitoring of primary elements, not only were the excavated fill and overburden visually identified and logged, but samples were taken initially on ten foot centers and submitted for analysis. Once the overburden and fill characteristics were well mapped, samples were taken usually on observed change of material and at top of rock only. In areas of soft zones, samples were taken every five feet of excavation. The material encountered in these zones, although of a less compact nature than elsewhere, posed no problems for construction. Material excavated by the rock drill was continually monitored by geologists since this was critical to the founding elevation. All solution related features - weathered limestone, clay, and grout - were noted and properly logged. Five primaries and two secondaries were deepened below contract depths due to observation of solution feature material during rock drilling operations or cleaning of bottom after rock drilling. See Construction section of this report, and Appendix A,Contract Drawings, Plate A-5, for details.

Slurry levels were difficult to monitor constantly during overburden excavation in the primary elements due to casing height, rapid advancement of the hole, and removal of slurry in the clam buckets. levels were taken periodically during this phase of operations however, and serious losses would have been detected had they occurred. Levels were taken with accuracy during idle construction periods. Some minor loss of fluid was observed as the excavation proceeded at depths at and below sandy alluvial zones below the gravel filter blanket. Mud tests were taken on an average of four per shift per element and consisted of density, pH, viscosity (marsh funnel) and sand content. No problems were encountered with the fluid in the primary overburden excavations.

Slurry levels were also taken in all secondary excavations. During idle periods it was observed that secondaries lost more fluid on the average than primaries, although no losses were considered serious. However, all holes which were observed to be losing fluid were monitored constantly and closely. The prime cause of fluid loss in the secondary elements was due to the high pH of the fluid resulting from contact with cement in an annular space grout holding surrounding primary casings in place. The high pH caused the bentonite to flocculate, robbing it of its pore sealing capabilities. The probable reason that no holes exhibited serious leakage is that the sandy alluvial layer, in which leakage should occur with flocculated slurry, had already been saturated and sealed by fluid from surrounding primaries. The high concentration of suspended material inherent with secondary excavation procedures also acted to block leakage pathways.

Mud testing of secondaries was also performed initially at the rate of several per shift. As indicated above, high pH's and densities were always observed. The densities increased proportionally with depth with high readings near eighty PCF. Seventy two PCF was set as a maximum density, and as this reading was exceeded, the contractor was directed to reduce the density to the specified limit. Readings at various depths were taken with a depth messenger sampler. The pH was invariably over 11, and the sand content (composed mainly of annular space grout particles) averaged 10 to 20 percent.

During rock drilling operations, mud levels, believed to be a critical observation, were considerably easier to monitor. A constant, reverse circulation system kept most of the fluid within a closed system, and a low constant casing height facilitated observation. Correlation needed to be maintained only with negligent spillage and increasing hole depth. No elements of the embankment wall were observed to lose a serious quantity of fluid; however, any minor loss was immediately closely monitored and several holes were treated with micatex to stop 0.1 to 0.3 foot per hour losses. Never used, but available if necessary, was a quantity of premixed bentonite slurry of greater density and viscosity than normally used, ready to be pumped into the excavation. In the switchyard wall, several holes were observed to lose substantial fluid, but it was determined that the loss was through intersecting drains and out weep holes in the tailrace retaining wall.

Mud testing of slurry during rock drilling operations was identical with procedures used during overburden excavation except tests were run every 5 feet.

An item of investigation, and also part of the contract was the test coring below each primary element. Each primary, after determining that the last ten feet drilled appeared sound, was further explored by drilling NQ diamond core holes to specified depths. All core was logged by geologists. All core was found to be of an unweathered nature and subsequently no elements were required to be deepened because of the coring program. All holes were pressure tested and pressure grouted, regardless of pressure test results.

Also, an item both of investigation and contract requirement was the coring of concrete in specified completed elements. This item will be covered in depth in following sections of this report.

4-05.5.3 Primary Element Construction Sequence.

4-05.5.3.1 Embankment and Overburden. The contractor used a 53 inch diameter toothed clamshell operated from a 45 ton Link Belt crane to open the primary elements. An open hole was advanced to between 72 and 80 feet, approximately reservoir elevation, before the addition of the bentonite slurry. Verticality of this first stage uncased hole was maintained by the technical specialist by using a marked straight edge extended across the opposing survey marks in the guidewalls in relationship with the supporting cable of the crane. If holes deviated from plumb in this upper section, the specialist directed the bucket be forced to the side and used it to shave the hole back to vertical. A weak slurry of specific gravity 1.02 to 1.05 was

now added and was maintained at or near the top for the remainder of the excavation process.

After the slurry was added, 47 inch outer diameter steel temporary casing of approximately one inch wall thickness was installed and a casing driver mounted. The contractor used flush jointed, slot-in-groove casing, being much more manageable than threaded casing at this size. The casing driver pushed, twisted, pulled and dropped the casing through the embankment while smaller clam shells were utilized for excavation. Funnel shaped guides were installed in the top of the casing to facilitate the insertion of the clamshell. The 47 inch casing string was advanced to approximately 142 feet where another string of 41.25 inch outer diameter, with approximately one inch wall thickness, flush joint casing, was telescoped through the larger. The smaller string was advanced in the same manner of excavation to top of rock. The base of the casing was of a saw tooth design, and when rock was encountered the casing was rotated and pushed in an attempt to obtain a rock/overburden seal, since it was felt that this area was critical as a possible failure or blow-out zone. Although this method was used for the entire project, after several observations of outside versus inside slurry levels and the lack of penetration of the casing into the rock, it was decided that there was not a very effective seal obtained. This was probably due to the hardness of the crystalline limestone and mortar grout encountered, and the crudeness of the saw-tooth "bit".

Excavated material was dumped from the clams into skip pans situated near the elements. Load lugger trucks were used to transport the spoil to the disposal areas.

Verticality tests were run periodically throughout the excavation to maintain less than the maximum 6 inches deviation from vertical in any direction at any depth. See section 4-05.5.3.5 for procedures used for testing. Jar samples of the embankment and alluvial material were taken at intervals throughout the excavation process and were sent to the District laboratory for classification. Bentonite slurry levels and tests for density, pH, viscosity, and sand content were taken by both Q.A. and Q.C. at specified intervals and adjusted if necessary for specification tolerances.

For pay purposes, both contractor and government representatives signed top of rock forms agreeing to the depth to the nearest tenth of a foot. Before proceeding with rock excavation, the rock surface was cleaned with a smooth jawed clam bucket and the slurry level monitored for a minimum of 4 hours.

4-05.5.3.2 Bedrock Excavation. Bedrock excavation for the primary elements in the embankment wall other than the tie-in section was accomplished by a Hughes 820 shaft drill, platform mounted, using 36 inch diameter roller rock bits. Drillers/Kentucky Limited, the subcontractor, used the reverse circulation method of fluid control. This method gave greater efficiency in removing cuttings while allowing the boring to be advanced with a minimum of hydrostatic pressure on the bottom of the hole. Drilling usually progressed at a very slow rate in attempt to maintain verticality tolerances. Even so, many shifts of reaming time were required to correct verticality discrepancies. The tie-in section and the switchyard wall was drilled by ICOS using their

Hong Kong Drill. It utilized procedures similar to the Hughes drill, including reverse air circulation.

The air assisted drilling method (reverse circulation) was permitted under modification 17 to the contract and resulted in a $75,000 savings to the government. The original contract disallowed the use of compressed air or blasting in excavation of the elements of the wall. After several discussions with District and Division personnel, the Board of Consultants, and the contractor, a fail-safe method of air assisted drilling was agreed upon. Compressed air, controlled by adjustable check valves, was forced down the annular space of double wall drill rods. The annulus was blocked by steel plates 50 feet above the bit and the air fed through holes in the inner wall above the plate. With circulation attained the cuttings were air lifted to a shale shaker and sand separators (hydrocyclones) and the fluid gravity fed back into the hole.

Five primaries and two secondaries were deepened below contract specifications due to observation of solution feature material in rock drill excavation to insure the 10 foot minimum in sound rock. P-351 was deepened from 212.5 to 218.0 after observing clay in cuttings from 211 to 211.4 feet. P-261 was deepened from 212.5 to 215.0 after observing clay and weathered limestone from 212.0 to 213.5. (Presumably the 10 foot minimum was ignored in this case as the two adjacent primaries had been completed with no evidence of solutioning disallowing the practicality of deepening the intervening secondaries.) After rock drill operations had been completed on P-239 the clam bucket cleaning the bottom for start of core drill operations recovered a piece of bedrock of boulder size which showed a weathered bedding plane. Subsequently, the hole was deepened from 217.5 to 227.5 feet. It was also decided to deepen the adjacent 2 holes on both sides to 227.5 (S-238,S-240,P-241, and P-237). No indications of weathering was found in any of the other holes.

4-05.5.3.3 Core Drilling, Pressure Testing, and Grouting. Upon completion of the rock excavation, core drilling and pressure testing was performed to further determine if the base of the wall was in sound rock. The depth of the borings was either 25 or 40 feet below grade, depending upon the final grade of the wall and the depth to the Leipers formation. All core was logged by government geologists. The core was photographed with both color slide and print film and was put in permanent storage in the core shed built on site under contract specifications. Core logs and photographs were included in the permanent log file record for each element.

The core drill subcontractor, Geotek Engineering Co. of Nashville, Tennessee, utilized a truck mounted Mobile B-53 drill using NQ wireline tools. The driller centered the drill over each element and set NQ casing 4 to 6 inches in rock. Water was used exclusively for drilling fluid. No hole had to be deepened from findings in core evaluation.

Figure 4-1. Primary Element Construction Sequence

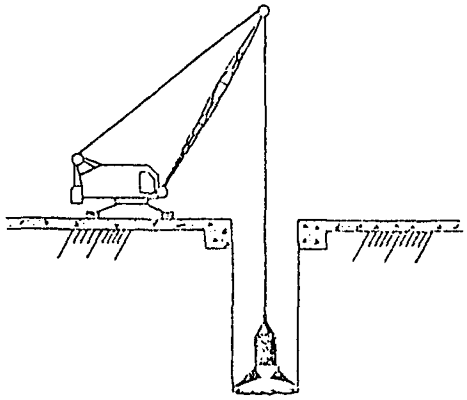


Figure 4-1a.
53-inch diameter uncased excavation to approximately 76 feet.

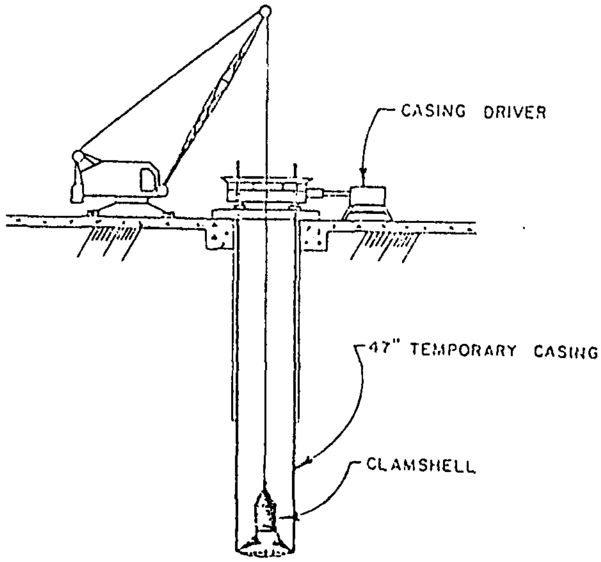


Figure 4-1b.
1. Position hydraulic casing driver.
2. Insert 47-inch diameter temporary casing 80 feet long.
3. Check verticality.
4. Add bentonite slurry and maintain near top of ground the remainder of excavation.

Figure 4-1. Primary Element Construction Sequence, Continued.

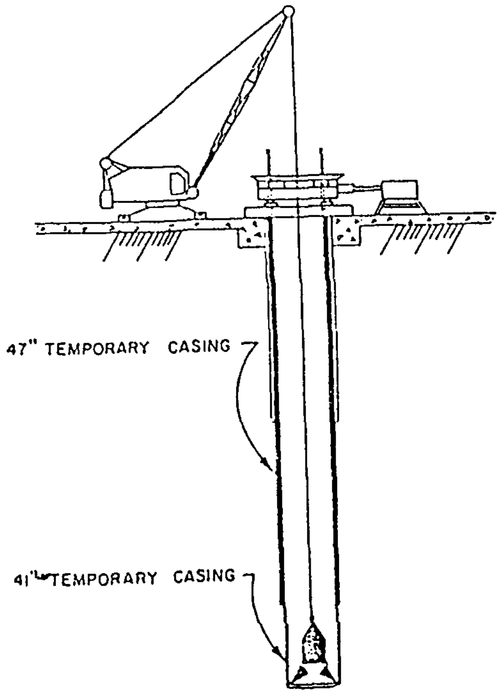


Figure 4-1c.
1. Excavate to approximately 140 feet while simultaneously driving 47-inch casing.
2. Check verticality.
3. Telescope 41.25-inch casing through 47-inch casing and continue excavating to top of rock while driving 41.25-inch casing.

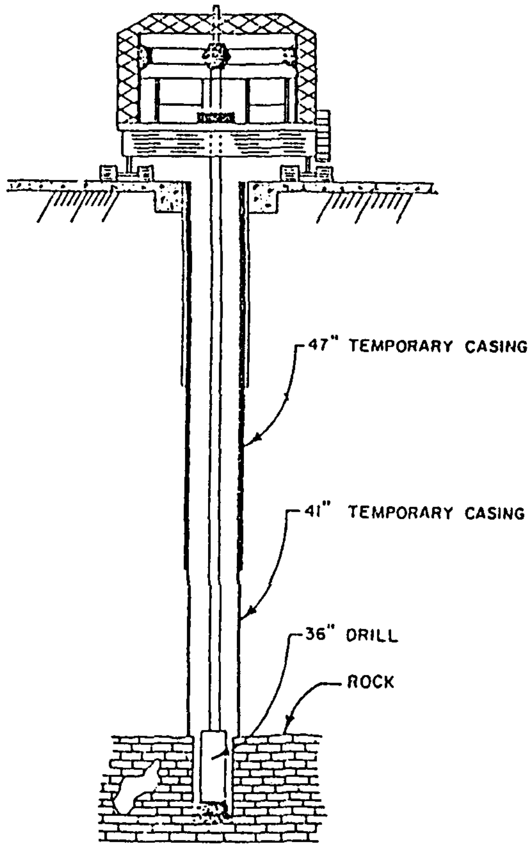


Figure 4-1d.
1. Drill hole to required elevation.
2. Check verticality.

Figure 4-1. Primary Element Construction Sequence, Continued.

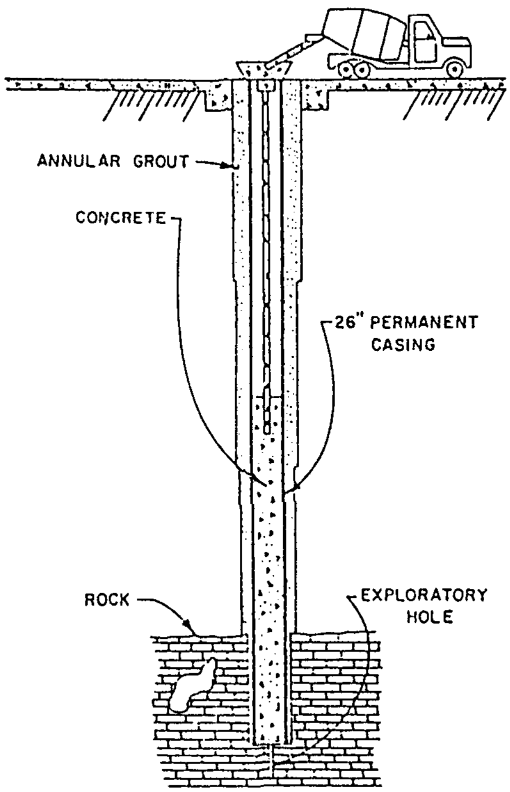


Figure 4-1e.

1. Perform exploratory core drilling, pressure testing and grouting.
2. Install 26-inch diameter permanent casing.
3. Take final verticality.
4. Place annular space grout and pull temporary casings.
5. Tremie concrete to complete element.

A single packer was used for pressure testing, set usually at 10 to 12 foot intervals from the bottom of the hole upward. A gauge pressure of 50 psi was held for 5 or 10 minutes for each increment and the take recorded in cubic feet per minute.

Regardless of the pressure test results, each hole was pressure grouted. The packer was set at the top of the NQ hole and a gauge pressure of 20 psi was maintained. As specified, the contractor pumped 3 to 1 by volume water to cement neat cement grout for a minimum of 20 minutes. After that time refusal was set at 0.25 cubic feet per minute. After refusal, the thin grout was displaced with a backfill mixture of 1 to 1 by volume neat grout.

The grouting under this contract resulted in an overall average of 0.065 bags per foot drilled, including the backfill. 0.065 minus 0.033 sacks per foot of backfill minus 0.014 sacks per foot of 3:1 grout washed from the hole equal 0.018 sacks per foot take in rock (actually somewhat less than this since an excess of 1:1 was pumped to ensure a full hole). The maximum grout take for a single hole was 9 bags.

4-05.5.3.4 Permanent Casing Installation. The contractor once again cleaned the bottom of the element with a smooth clamshell after core drilling, this time to remove drill cuttings and excess grout in preparation for permanent casing installation. The casing used was 26 inch outer diameter, 25.3 inch inner diameter, steel, tapered to 22 inches at the closed lower end. An 80 foot section was initially lowered into the hole, aided by an 11 ton ballast and water to overcome buoyancy. Displaced slurry was allowed to flow laterally between the guidewalls, and if there was an excess, it was drained through the series of drain pipes to the settling pond at the base of the dam. The second, third, and when needed, fourth sections of the casing were individually held in place by the 100 ton utility crane and an alignment collar set on the top of the preceding joint. Brackets were welded at the third points around each casing and hydraulic jacks were set to align the casings. Alignment was assured by inserting a 26 inch plumb bob into the first section of casing. When the casings were properly aligned, certified welders would then tack weld the joints through small openings in the alignment collar. Upon removal of this collar, the joint was then welded solid.

The final verticality test was taken when the welding was complete and the 26 inch casing was resting on the bottom. Adjustments were frequently made to slightly reposition the casing to obtain the greatest vertical accuracy. The final verticality was recorded and included in the folio of information kept on each element.

The final stage of the permanent casing installation was the injection of grout to hold the casing in place awaiting concrete placement and secondary element installation. With the permanent casing wedged into place, the 47 inch temporary casing was pulled from the hole. The 41.25 inch casing was pulled up 6 to 8 feet and held in place with the casing driver. Two inch pipe was installed to the bottom of the hole by Geotek and the subcontractor began pumping grout. The grout used, called annular space grout by the contractor, was a low strength mix designed to make the task of excavating the secondary elements as easy as possible and still hold the permanent casing in place with no

danger of moving while placing concrete and during secondary excavation.

Prior to the removal of the 41.25 inch temporary casing, approximately 50% of the annular space in the element was filled with grout. The upper half of the excavation was protected by the bentonite drilling fluid displaced by the bottom hole injection of the annular space grout. At this point all the 41.25 casing was taken out of the element. The 26 inch casing was then realigned, and held in position by a special bracket which was attached to the inner edge of the guidewall. The grout pipe was then placed back into the element and the remaining annulus was filled with annular space grout. The grout was given approximately two weeks to set up before tremie concrete was placed in the element. See table 4-2 for mix design of the annular space grout.

TABLE 4-2
Mix Design for Annular Space Grout

990 pounds water........................	15.87 cu.ft.
54.5 pounds bentonite....................	0.34 cu.ft.
481 pounds Portland cement...............	2.44 cu.ft.
369 pounds fly ash.......................	2.28 cu.ft.
22% air..................................	6.03 cu.ft.

4-05.5.3.5 Verticality Testing. The verticality of the elements which has been previously mentioned frequently was measured by the contractor quality control section. They utilized the system of survey points set in the concrete measured against a plum line in the hole. A plum bob was used which weighed approximately one ton, the diameter of which was compatible in size with the different casings. The plumb bob was made up with a central latching socket for positioning and retrieving. A 3/16 inch wire rope ran through a sheave which was mounted on a planetary gear supported by a steel tripod. The cable was latched into the top of the plumb bob. Two zero adjusting line levels were mounted horizontally and at 90 degrees to each other on a two piece bar that could be clamped coaxially to the 3/16 inch cable. These two levels of 2 second sensitivity were calibrated on a plumb cable prior to use.

The plumb bob was lowered into a casing to the desired location. The cable was attached to the plumb bob and tension was applied to straighten the cable. Next, the bar containing the line levels was secured to the cable and the cable was then plumbed by using the planetary gear on the tripod. With the line plumb, accurate measurements could be taken from the line to the control points on the guide walls. Thus, an accurate location of the casing could be plotted.

During the embankment excavation a verticality test was performed at every change in diameter of temporary casing. Supplementary verticalities were carried out as required. The specified final verticality tests were performed in the 26 inch permanent casing at 30 foot intervals. The final verticalities were plotted and became part of the folio of information permanently maintained.

The 36 inch drill hole was also tested for verticality while being advanced, but by a different method. The subcontractor utilized a Totco "Go-Devil", a progressive slope indicator which is encased in a tube and is centered in the drill rods by flexible fingers. The alignment was measured at the bottom of the drill rods and was read in degrees of slope. Measurements were usually taken on a 10 foot frequency but were required to be taken at 30 foot intervals.

4-05.5.3.6 Tremie Concrete. The filling of the permanent casing with concrete completed the sequence of the primary element construction. Since the procedure for secondary element placement was identical but the results were somewhat different this topic will be covered under separate heading 4-05.5.4 and a discussion of related problems with analyses of problem placements and concrete test core summaries can be found in Appendix D.

4-05.5.4 Secondary Element Construction Procedure. Wolf Creek rigs were used exclusively to excavate the annular space grout, embankment, and rock between the primary elements. These secondary elements were completed without the use of casing, but did utilize a full head of bentonite stabilizing fluid.
Bi-concave clam chisels were used to excavate the embankment and overburden portion of the wall and a variety of bi-concave "side" chisels and star chisels were used in the rock.

Excavation began with a bi-concave toothed clam chisel which was used to top of rock. The central clam bucket of this unit removed the material while the bi-concave sides cleaned the 26 inch permanent casings on which they rode. Due to chiseling action, and flocculation caused by the cement in the annular space grout, it was necessary to regularly clean and replace the slurry. Bailing was used to remove the dense, sandy suspension found at the bottom of these excavations while either water or thin bentonite was added at the top.

Beginning at top of rock, 3 devices were used in regular sequence. First, a star chisel was used to pulverize the rock in the center of the hole for about 3 feet. Then a bi-concave "side" chisel cleaned the side rock and casings for the same depth. Thirdly, the bailing device was used to clean the heavily suspended rock, sand. and grout debris from the bottom of the element, completing the cycle.

At bottom design grade, a verticality test was run which measured the horizontal distance between primary element casings at 30 foot intervals. The measured increments were compared against the mathematically calculated theoretical and was considered to pass if the difference was less then 0.3 feet. The measurements were taken with the bi-concave chisel lowered to the specified depth and the shoulders opened as wide as possible with the operating cable with the weight of the chisel held by the holding cable. The vertical distance relative to the holding cable with the operating cable moved to fully open was indicative of the width at any point. If the verticality was not found to be in tolerance at any depth, it was because the permanent casing had not been properly cleaned. These situations were rectified by

Figure 4-2. Secondary Element Construction Sequence.

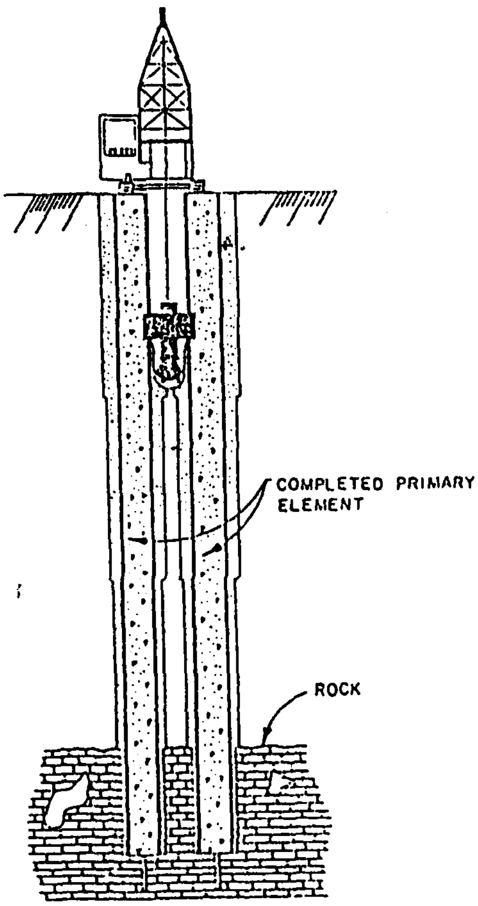


Figure 4-2a.
Soil and annular space grout removal by Wolf Creek Rig using biconcave clam bucket.

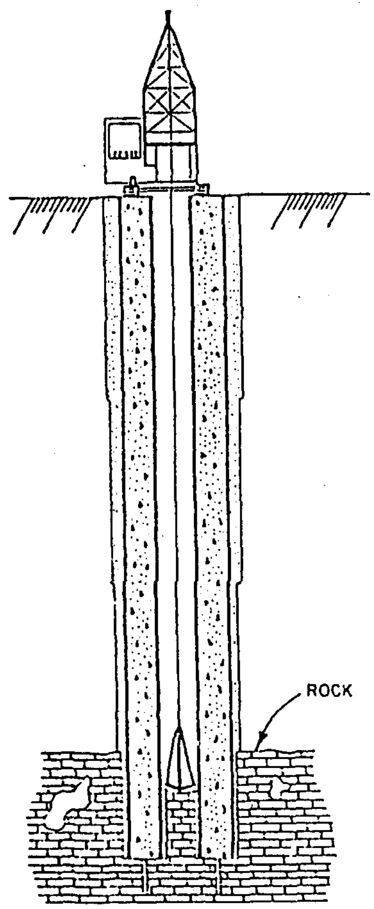


Figure 4-2b.
Rock and annular space grout removed by alternating star chisel, biconcave side chisel and bailer. Verticality is checked, hole desanded, and tremie concrete placed.

rechiseling to specifications before concreting.

When design depth was obtained, the contractor simultaneously cleaned the bottom of the element and desanded the slurry in preparation for concrete. The procedure used was air lift circulation through a rock and sand separator. Circulation was obtained through an 8 inch pipe with a rubber air hose injecting compressed air through a fitting some 20 feet off bottom. The pipe was initially bounced on the bottom several times to retrieve the larger material, then left to desand the slurry until less than 1% sand content was obtained. At this point the hole was ready for tremie concrete.

4-05.5.5 Tremie Concrete Procedures.

4-05.5.5.1 General Procedures. Elements were completed with the placement of concrete by the tremie method, inside the 26 inch casing for primaries, and in the open excavations for the secondaries. The first placement was made on 5 April, 1976.

Several minor changes were instituted during the course of the contract to improve the quality of the product and will be discussed in this report. Originally, the procedure called for lowering a string of 10 inch threaded steel pipe to within 12 inches of the bottom of the permanent casing or rock as the case may be, and attaching a 1/2 cubic yard funnel shaped hopper to the top. The string was manipulated with either an 18 or 35 ton hydraulic utility crane. A standard basketball was placed in the hopper to serve as a retrievable traveling plug or "go-devil",as specified in the contract, to partially maintain a concrete/water barrier during the start of placement.

Two mixer trucks were directed to the hopper, one with 2 cubic yards of grout, and the other with 8 yards of concrete. The grout was released first, quickly followed by the concrete. Concrete continued to be supplied by mixer trucks with no or minimum delay until placement was completed. The surface of the rising concrete was sounded with a heavily weighted tape to insure a minimum embedment of 10 feet of tremie pipe in concrete as sections of pipe were removed.

Concrete placement during the early period of the contract was done with little regard to the rate of concrete rise or the amount of pipe embedment other than to insure a minimum of 10 feet was maintained and that head differential was such that placement could continue with as little rapid up and down movement of the pipe and hopper as possible. The rate of concrete rise within the 26 inch casing was approximately 12 feet per minute, and slightly slower in the secondaries.

A considerable quantity of grout and laitance was observed prior to the show of concrete at the surface on many of the primary elements. This was not observed during the tremie concrete placement for any of the secondary elements. The concrete rose to the surface of the secondary elements with practically the same consistency in which it was placed.

4-05.5.5.2 Trouble Shooting Problems. Early in the contract, test borings of random elements revealed substandard concrete in a percentage of primary elements. The Contracting Officer requested changes to the tremie procedure on 5 April, 1977, to attempt to

alleviate the initial show of laitance and grout and the zones of poor quality concrete being found in the primaries. The rate of rise for the concrete was changed to be no greater than 8 feet per minute. The slump was changed from a range of 6.0 to 8.0 inches to 6.5 to 7.5 inches. The maximum tremie pipe embedment was set at 90 feet with the minimum remaining at 10 feet. A solid wooden sphere of 9.7 inches in diameter replaced the basketball "go-devil". The tremie pipe was lowered to within 0.3 feet of the bottom prior to placement. Approximately one cubic yard of concrete was placed on top of the wooden ball and the tremie pipe was raised to one foot to allow the escape of the ball and start the flow of concrete.

Loss of seal procedures were also changed at this time. Two elements had experienced a loss of seal, and the established procedure of reinserting a dry pipe in the concrete and continuing placement was not properly followed. Corrective action taken involved grouting and redrilling measures (see Appendix D for details). Consequently, the Contracting Officer directed the contractor not to attempt to recover a loss of seal, but allow the concrete to set, clean by air lifting and begin a new placement.

The changes resulted in less grout and laitance, and a subsequent loss of seal was successfully carried through with the new procedure. However, occasional substandard concrete was found in later test borings. Although considerable time and effort was spent in an attempt to rectify the problem, since the areas in question were isolated to the primary elements, it was decided that with the presence of the steel casing there was little threat to the safety of the structure. The last tremie placement was made on 3 February, 1978.

4-05.5.5.3 Concrete Mix Designs. The concrete mixes were designed by the prime contractor. The first mix used was composed of the following:

coarse aggregate..........1575 pounds
fine aggregate............1243 pounds
cement.....................564 pounds
flyash.....................155 pounds
water.......................36 gallons
air..........................6 percent

After placing several elements there was a determination that there was a loss of air during placement (bleeding). On 19 April, 1976, the mix was changed to the following:

coarse aggregate..........1600 pounds
fine aggregate............1380 pounds
cement.....................564 pounds
flyash.....................115 pounds
water.......................32 gallons
air........................2.3 percent

This mix, used for the remainder of the contract, had a 0.40 to 0.41 water to cement ratio and yielded a slump of 7 to 8 inches.

The cement was type II low alkali. It was furnished at the beginning of the contract by Diamond Kosmos Cement Company. After about 250 tons had been shipped, a breakdown occurred at the Kosmos plant, and the remainder of the cement was shipped from the Speed, Incorporated plant of the Louisville Cement Company. All cement was accepted by a mill certificate issued by the cement company.

Pozzolan (flyash) for the project was furnished by the Walter N. Handy Company of Louisville, Kentucky. The tests for acceptance were performed by the concrete division of the USAE Waterways Experiment Station at Vicksburg, Mississippi. The supply plant for the flyash was Louisville Gas and Electric Company, Cane Run Plant, Louisville, Kentucky. The government inspector was Mr. Larry Daniels.

The air entraining agent used was MBVR Standard furnished by Master Builders Supply Company, Incorporated, Cleveland, Ohio. The test samples were taken by project personnel and sent to the Ohio River Division Laboratory at Cincinnati, Ohio, for testing and acceptance according to Corps of Engineers specification number CRD-C-13.

The mixing water for the concrete was obtained from an on-site well. The water was tested by T. M. Reagan, Incorporated, Environmental Engineering Services, Lexington, Kentucky. Based on the test results and the standards of the Portland Cement Association for mixing water for concrete, the well qualified as an approved source of mixing water.

The fine aggregate was natural Ohio River sand, supplied by the Martin Marietta Company, Incorporated, of Milton, Kentucky. The sand was loaded on barges at the plant site and was shipped up the Kentucky River to Frankfort, where it was transferred to trucks and transported to the job site. A total of 203 gradation samples were run. No samples were found to be out of specified gradation. The average F. M. was 2.94. The following represents a typical gradation:

Screen Size	% Passing	Spec. % Passing
4	98.0	95-100
8	83.7	80-95
16	68.4	55-75
30	50.2	30-60
50	15.0	5-30
100	1.7	0-10

The coarse aggregate, 3/4 inch top size natural gravel, was screened and washed by the Green River Sand and Gravel Company, Incorporated, Jonesville, Kentucky. It was transported to the job site by trucks. A total of 198 gradation samples were run, with only 4 samples found to be out of gradation. Those out of gradation were on the 3/8 inch screen. A typical gradation:

Screen Size	% Passing	Spec. % Passing
1"	100.0	100
3/4"	97.3	90-100
1/2"	74.0	-
3/8"	28.1	20-45
#4	1.5	0-5

4-05.5.5.4 <u>Concrete Testing.</u> The Quality Control program for concrete testing was carried out in conjunction with the Corps' Quality Assurance program. The contractor made 5 concrete cylinders a placement day in addition to taking daily air and slump tests. All samples were taken at the tremie site as placement was in progress. The 6 inch diameter cylinders were taken to the Corps' on site laboratory for curing. They were marked to be broken as follows: 2 at 7 days, 2 at 28 days, and 1 at 90 days. The average 7 day cylinder failed at 2,840 p.s.i., the 28 day cylinders at 4,278, and the 90 day at 5,154. The average slump was 7 inches with the mean air content at 6.4% The Corps laboratory section ran gradations daily on both the fine and coarse aggregates.

The quality of the completed concrete in both the primary and secondary elements was checked by NQ size core borings. The drilling was performed by Geotek Engineering Company, of Nashville, Tennessee. They utilized two truck mounted drills, a Mobile B-53 and a Mobile B-61. All coring was done using NQ wire line drilling tools, having a core diameter of 1.875 inches. There were a total of 20 primary elements and 29 secondary elements test cored. In general, all secondaries had sufficiently good quality to alleviate any concern as to those portions of the wall. As previously mentioned, the quality of the concrete in the primaries was, in many instances, of a very poor nature. Lost core was not logged for any secondary element, but was recorded in 40% of the primaries, from a minimal 0.1 foot to a disturbing 41.9 feet. For drilling summaries of each element tested, see Appendix D.

4-05.6 <u>Problems During Construction.</u>

4-05.6.1 <u>General</u>. The prime contractor generally exhibited a high level of expertise and professionalism, and as a result avoided or quickly resolved many potential problems which have been known to plague other slurry wall projects. For example, the extremely stringent verticality requirement could very well have resulted in many lengthy delays and possibly contractor/government friction, but it was anticipated, accepted, and successfully carried through. There was one problem involving verticality which involved some delay; it will be discussed in this section. The most serious problem encountered during the project, the concrete quality in the primary elements resulting from mix design, placement procedures, losses of seal and stuck tremie pipes has already been discussed and will be further documented in Appendix D.

There were, of course, minor problems, not the least of which was communication between government field personnel (who spoke no Italian) and many of the contractor personnel (who spoke very little English). Interpreters were occasionally required, but there were very few delays resulting from this.

During the course of the contract, Kentucky experienced two of the most severe winters on record, and several working days were lost - an unusual occurrence in slurry wall operations. Combined with strikes and labor disputes, the contract length was extended by some 97 calendar days.

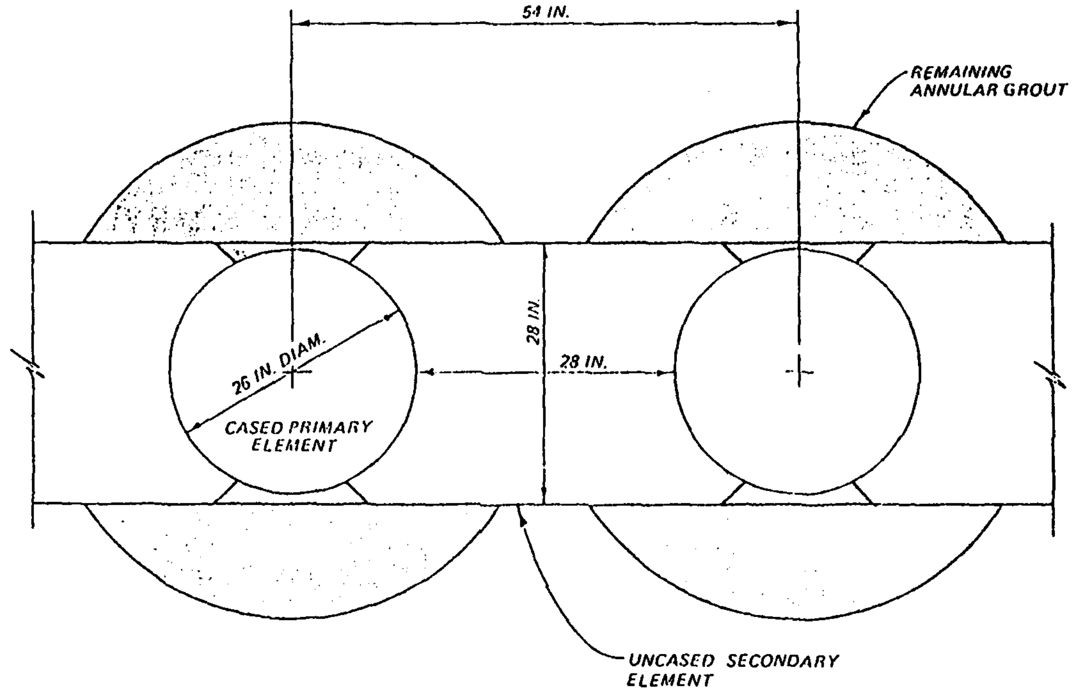


Figure 4-3. Plan of completed wall segment.

Several other difficulties which either delayed the contractor or were not readily resolved are discussed below.

4-05.6.2 Tie-in to Existing Concrete Structure - Embankment Wall. At Wolf Creek, the embankment wraps around the concrete portion of the dam, the end face of which slopes on one horizontal to ten vertical. It was correctly assumed that alignment would be difficult to maintain while drilling through this contact, and a separate lump sum bid item was provided in the contract to help offset the anticipated problems. 13 elements were involved, P-101 through P-113.

Very slow progress was experienced during the first of these elements to be constructed, P-103, which took 75 days to complete. Vertical alignment was the major obstacle to be overcome, with excessive reaming time involved. The prime contractor utilized their own drilling rig, the Hong Kong Drill, in lieu of their drilling subcontractor. At one point during the drilling of this element the rods twisted off and the remaining rods and bit assembly had to be fished from the hole. In subsequent elements, the contractor modified his procedure to provide for better stabilization of the drill tools and production rates improved. Some of the modifications tried included cutting the bottom of a section of 36 inch temporary casing on a slant for the concrete/embankment contact, the use of backfill concrete at the contact to make a level surface on which to start drilling, chiseling a starting surface with star chisels, the use of a smaller diameter pilot bit below the main assembly, and stabilizer guides in the temporary casing to help align the drill rods.

A loss of drill fluid occurred while drilling the NQ core hole below P-105, and it was found flowing into a dam gallery adjacent to the element. The water loss was stemmed with loss circulation material. A watch was posted in the gallery during all subsequent drilling activities in the tie-in section when it was considered possible that communication could occur.

4-05.6.3 Verticality of P-139. A survey error was made on the permanent casing verticality (final reading) before placing annular space grout. A recheck showed the casing to be out of tolerance with readings of 0.61 feet and 0.71 feet landward at 230 and 270 feet in depth respectively, but was not found until the grout had been placed. The contractor requested a waiver and proposed to slightly change the alignment of the adjacent primary elements (P-141 and P137) to better facilitate the construction of the closing elements S-138 and S-140. Permission from the Contracting Officer was granted and the installation of those elements were completed as revised. The location of the adjacent primaries were offset from design to the following stations: P-141 - 36+02.42L, 0.00 A and B; P-137 - 35+93.56L, 0.77B.

4-05.6.4 Stuck Chisel in S-394. ICOS was plagued with down time recovering stuck chisels - usually biconcave rock chisels (side chisels)- from the secondary elements. The episodes usually occurred when the holding cable broke and the edges of the chisel jammed apart against the primary casing from tension of the operating cable.

However, various other tools and various causes were also involved. Recovery normally took from tens of minutes to several hours, with an occasional chisel requiring more than one shift. A side chisel was stuck in S-394, however, which required continuous effort from 10 August, 1976, when it became wedged in the hole at 180 feet, until 5 October of that year, when it was recovered. Heavy construction equipment ranging from Wolf Creek Rigs to 100 ton cranes were intermittently tied up in the recovery effort. Specially fabricated hooks designed by ICOS' chief engineer ultimately led to its recovery.

4-05.6.5 Mud Level Monitoring. The initial indication of encountering open solution features during wall excavation was understood to be a rapid slurry loss. A possible pending emergency could be indicated by any degree of loss of slurry. Therefor, the Contracting Officer directed all personnel to be observant of the level of slurry in all open excavations, and for Quality Assurance personnel to accurately measure "mud levels" at specific intervals. However, losses, if any, were virtually impossible to calculate under dynamic conditions. Varying lengths of partially mud filled guidewall normally contained various excavation operations, each with different excavation rates. This, combined with the irregular trench bottom which occasionally contained completed primary casings, spilled piles of spoil, stored equipment, etc., made any accurately computed volume drop infeasible. There was also a significant mud loss from spillage from clam buckets and from spraying from the air lift equipment which was difficult to estimate. Field personnel were directed to attempt to correlate excavated volumes by estimating spoil deposited in skip pans with decrease of mud volume in the trench, but the variables mentioned made this prohibitively difficult. Semi-accurate readings were only obtained on isolated holes during periods of inactivity with mud levels lower than the base of the trench.

4-06 Site Restoration

4-06.1 General. The restoration for Phase I consisted of the removal of a portion of the work platform from the dam and the restoring of the work site around the switchyard to its original condition.

4-06.2 Embankment. Modification P00016, dated 17 March, 1978, extended the completion date for the removal of the Phase I work platform between stations 42+30 and 50+00 to coincide with the completion date for the Phase II contract. This portion of the platform contained the contractor's office trailers, workshop and bentonite mixing and storage tanks. The portion of U.S. Highway 127 was restored to its original alignment between station 35+11 and 42+50. Two way traffic was reestablished across the dam and continued throughout the diaphragm wall construction period.

The restoration work began with the concrete backfilling of the pipe and guidewall trenches. The concrete and asphalt working surface was then removed as was the downstream rock fill used to construct the platform. The tie-back rods from the anchor wall to the sheet piling

were dismantled and the piling was extracted. The rock fill was hauled to a slough at the east abutment of the dam where a future parking lot and a boat launching ramp were to be constructed. The impervious embankment was returned to its original slope and a four inch thick plating of top soil was added. The slope was fertilized, seeded and mulched according to the specifications.

Base course asphalt was placed on the portion of U.S. Highway 127 between stations 35+11 and 42+50 as this section was restored to the original alignment. The wearing surface would be laid in conjunction with the restoration work for Phase II.

The upstream portion of the work platform was removed using the same method as was used in the removal of the downstream platform. A section of the upstream guidewall and the top three to four feet of the concrete diaphragm wall was removed between stations 36+65.22L and 38+59.30L. This section contained the upstream alignment change to the diaphragm wall for accommodation of the steel tailtower structure incorporated in the embankment during construction. The top width of the dam was widened by 7.75 feet to the upstream side by leaving the remaining concrete guide wall in place.

New guardrail was installed along the restored section of the dam. The new rail was required to comply with Kentucky's Bureau of Transportation specifications. The work was accomplished under a modification to the contract.

The disturbed portion of the upstream side of the dam between the service road, at elevation 740 feet MSL and the top of the dam was graded for new rock protection. The subcontractor, E. Randle Company, using an endloader, dozer and backhoe, placed the required one foot of bedding and three feet of rip-rap on the slope. This new protection extended from the embankment wrap-around section to station 41+34 where the work platform remained intact. The limestone bedding and rip-rap material came from the approved quarry at Albany, Kentucky.

Throughout the construction and restoration phases, six piezometers were rendered inoperable due to their alignment with the diaphragm wall or to the contractor's surface operations. The specified money was retained from the contractor for each piezometer destroyed. During restoration the piezometers and inclinometers were protected by temporary means. The piezometers on the upstream and downstream slopes had high riser pipes installed to protect them as the rock protection and the embankment were repaired. The temporary risers were later cut to the appropriate height and new elevations were established for each.

4-06.3 Switchyard. The restoration of the area around the switchyard was accomplished without difficulty. Tennessee Valley Authority crews removed the temporary power poles, which elevated the transmission lines above the switchyard as ICOS was removing their equipment from the area. The guidewall trench was backfilled with concrete and the parking area was paved with two inches of asphalt. The surrounding disturbed area was regraded, plated with topsoil, fertilized, seeded and mulched according to the specifications. The weather station and shrubbery were replaced between the parking lot and the tailrace training wall. The concrete ditch and the rock protection along side the switchyard were replaced.

4-06.4 Final Acceptance. The final formal acceptance of this partial restoration for Phase I construction was delayed until 19 August, 1980, when the complete dam restoration for both Phase I and Phase II was reviewed and accepted.

SECTION 5 - Instrumentation

5-01 General. Wolf Creek Dam, due to the foundation problems and remedial work, was highly instrumented and carefully monitored. This instrumentation system included some 300 open tube piezometers, pressure transducers, inclinometers, seismic instruments and surface monumentation. Piezometer types included casagrande, well point, and pneumatic. The pneumatic piezometers and the transducers, installed under this contract, were equipped with automatic, continuous recorders. Approximately fifty of the other piezometers were read six times daily during wall construction and the remainder were read weekly. Water temperatures were measured at the bottom of the top of rock piezometers every two to three months. Monumentation surveys were performed semiannually, unless specifically requested and inclinometer readings were made at three month intervals. Data was compiled and analyzed by the Nashville District Instrument and Inspection Section.

5-02 Piezometers. All piezometer readings were plotted as head elevation versus time. Those piezometers read six times daily (every four hours - seven days per week) were also plotted on an hourly scale and these plots compared to a plot of the work in progress (on hourly scale) from which the specific drilling, grouting, etc. reactions could be determined. Factors used in the evaluation of piezometer reactions are as follows:

1. Individual plots compared to headwater, tailwater and rainfall.
2. Evaluation of reactions to wall operations.
3. Evaluation of large hole drilling versus small hole rock drilling.
4. Evaluation of base level changes.
5. Piezometer water level contours.
6. Piezometer temperatures.
7. Correlation of piezometer data with known geology.
8. Insuring the operational adequacy of the piezometers.

Every three months contours of the top of piezometer levels were plotted. These were evaluated in light of theoretical contours, work underway, known geology and seasonal fluctuations. Temperatures from top of rock piezometers are plotted as contours. Zones of colder water from the reservoir, passing through the foundation could be detected in this manner.

5-03 Automatic Recording Instruments. A system of ten automatic recording transducers and pneumatic piezometers, one of each installed in the same hole, was installed to evaluate the effect of airlift

drilling and other construction practices on the foundation. Although occasional dynamic responses have been recorded (which would have been missed by manual readings), problems with the transducers and with the pneumatic piezometers' recorder limited the success of this system. However, when the pneumatic piezometer recorder was functioning properly, correlation with construction progress was dramatically shown.

5-04 Inclinometers. The contract required the installation of seven inclinometers to monitor any movement in the diaphragm wall. The inclinometers were installed in secondary elements of the wall. For their locations see Appendix A, Plate A-58.

ICOS prefabricated 15"by15" resteel cages in which was anchored a four inch steel casing. The cage and casing were lowered into the cleaned secondary element just before tremie placement. The resteel cage and casing provided a fixed preformed hole for the insertion of the 1.90" diameter plastic inclinometer casing. Initial installation was under the direction of a representative from Slope Indicator Company, the manufacturer of the instrument. Once initial readings were established, the Instrumentation Section from the Nashville District assumed the responsibility for compiling and interpreting the data. Very minor movements have been observed since the initial readings were recorded.

5-05 Other. The seismic instruments were checked periodically for movement; however, those near the construction were disconnected due to numerous false recordings as a result of the construction. Monumentation surveys were discontinued during the construction period on the embankment but continued in the switchyard, which showed no appreciable movement. A survey on the embankment after completion of construction also revealed no appreciable change.

SECTION 6 INSPECTION.

6-01 Contract Administration. This contract was administered by the U.S. Army Corps of Engineers, Nashville Engineering District, Nashville, Tennessee, and was executed under District Engineers Colonels Henry J. Hatch, Robert K. Tenner and Lee W. Tucker.

6-02 Personnel. Inspection in accordance with paragraph G.P.-50 of the General Provisions was performed under the direct supervision of Mr. Joseph R. Turner, Resident Engineer. He was assisted by numerous government personnel. See Table 6-1 for the list of personnel and their effective dates.

6-03 Records. All administrative records are on file at the Office of the District Engineer, U.S. Army Engineering District, Nashville, Tennessee. Detailed construction files were maintained with separate folders for each element filed in both numerical and chronological order. The folders contain detailed logs covering each phase of construction operations. See Appendix C for examples of the various logs and other construction records. These files are currently being maintained at the Wolf Creek Powerhouse.

6-04 Final Inspection. The final inspection was held simultaneously for both Phases I and II on 19 August, 1980. Representatives of the District Office, at the Wolf Creek Resident Office, and ICOS Corporation of America performed the inspection.

TABLE 6-1

GOVERNMENT PERSONNEL

The following government personnel were assigned to this work:

Joseph R. Turner	Resident Engineer	4-75 thru 5-79
George Brunner	Assistant Resident Engineer	9-75 thru 7-77
Cecil Dodson	Acting Ass't Resident Eng.	9-75 thru 6-78
Duane Dyer	Acting Ass't Resident Eng.	9-75 thru 3-81
Junior Appleby		6-78 thru 9-78
James Baber		11-75 thru 5-79
Ralph Backhaus		3-78 thru 6-78
Arva Bernard		6-75 thru 7-80
Larry Brown		6-75 thru 3-81
Don Crane		4-77 thru 7-80
Bill Fanning		3-76 thru 2-79
Gerald Garner		4-76 thru 1-78
Wilfred Hagan		7-76 thru 6-79
Anita Hay		8-75 thru 7-80
Pat Jordan		11-77 thru 5-79
Bernie Kearns		8-76 thru 3-81
David McGowan		5-79 thru 9-80
Dick Orr		10-75 thru 12-76
Richard Powers		4-76 thru 6-77
Jerry Rainer		9-75 thru 6-76
Dan Riggs		3-76 thru 7-79
Paul Ross		10-75 thru 12-77
Paul Smith		9-77 thru 8-78
Peggy Webb		1-78 thru 9-79
Orville Wicker		3-76 thru 3-81
Glenn Wooldridge		6-78 thru 7-78
Everett Wright		3-77 thru 9-79
Phillip York		2-78 thru 2-79

SECTION 7. POSSIBLE FUTURE PROBLEMS.

The instrumentation indicates that the walls are functioning as designed. No problems are foreseen for the switchyard wall. For the embankment wall, although the concrete test cores indicate that the more vulnerable portion of the wall - the secondary elements - are probably fully closed, the possibility does exist that there could be windows in the structure. It is unlikely that, even if any windows are present,

their locations would be favorable for renewed piping, and equally unlikely that underseepage will occur either through the wall/dam contact or under the wall, due to the conservative procedures used and depths specified. However, there is precedent for underseepage to be resumed below concrete structures founded in so-called sound rock, and constant attention to instrumentation and visual inspection must be maintained.

The most likely future problem would be at the right end of the wall following completion of Phase II. The hydraulic gradient should be monitored closely to determine if future remedial action is to be necessary in this area.

WOLF CREEK DAM REMEDIAL CONSTRUCTION
CONCRETE DIAPHRAGM - PHASE II
COMPLETION REPORT

SECTION 1. INTRODUCTION

1-01 General. This report contains only the pertinent contract information for Contract Number DACW 62-77-C-0129, Phase II, and any changes in construction procedure from the Phase I diaphragm wall contract. Phase II was basically an extension of the Phase I embankment wall, and was awarded to the same prime contractor - ICOS Corporation of America.

1-02 Authorization and Appropriation. This contract was authorized by the Flood Control Act of 1938, Public Law Number 761, 75th Congress - 3rd Session. The appropriation code is 96X3122, Flood Control General.

SECTION 2. CONTRACT.

2-01 General. Two step bidding was again utilized in the Phase II contract, with ICOS Corporation of America and ECI-Soletanche being approved for bidding. ICOS was awarded the contract after submitting their bid of $46,456,600.00. ECI-Soletanche turned in a bid of $57,083,350.00. The government estimate, without profit, was $41,780,000.00.

The Notice to Proceed was signed by ICOS on 5 July, 1977, and the contract had a completion date of 18 October, 1980.

Mobilization began immediately with the extending of the Phase I work platform to include the Phase II working area. There was no break in time for the diaphragm wall construction activities as the two phases merged for element construction.

2-02 Modifications. During the course of construction, the contract was modified eleven times. These modifications are listed in Table 2-1.

TABLE 2-1
PHASE II MODIFICATIONS

Mod no.	Description	Change to Contract
P00001	Addition of retarding admixture to concrete mix design	None
P00002	Extended completion date due to weather and work stoppages	27 day increase

P00003	Extended completion date due to cement transportation workers strike	10 day increase
P00004	Exploratory drilling near P-1097	$21,606.29 increase
P00005	Coring and pressure testing elements S-974 and S-976	$14,029.05 increase
P00006	Extended completion date for weather	20 day increase
P00007	Install temporary access roads for required piezometer installation	$26,463,36 increase
P00008	Delete certain items from site restoration requirements in exchange contractors metal buildings	$23,600.00 increase
P00009	Purchase of office trailers	$12,000.00 increase
P00010	Lump sum payment for contract underrun	$40,000.00 increase
P00011	Establish new bid item No. 21 (administrative correction only)	None

2-03 Subcontractors. Table 2-2 lists the major subcontractors used in this contract.

TABLE 2-2
SUBCONTRACTORS

Subcontractor	Address	Responsibility
E. Randle Company	P.O. Box 396 Frankfort, Ky 40601	Work Platform
Duncan Machinery Movers	Old Frankfort Pike Lexington, Ky 40504	Moving machinery
Valley Fence Company	1300 West Oak Street Louisville, Ky 40201	Fencing
Geotek Engineering Company	2720 Nolensville Road Nashville, Tenn 37211	Core drilling
Harrod Carter, Inc.	P.O. Box 794 Frankfort, Ky 40601	Concrete

R.E. Gaddie, Inc.	P.O. Box 300 Bowling Green, Ky 42101	Paving and stone

2-04 Safety. ICOS submitted their safety plan and job hazard analysis immediately following the awarding of the contract. The plans took into consideration the historic values learned during the Phase I contract. The submittals were reviewed and accepted by District personnel.

The contractor maintained an excellent safety record. During the course of the contract there were only three lost time incidents which involved pulled ligaments and one broken wrist.

SECTION 3 CONSTRUCTION

3-01 Preconstruction Conference. The preconstruction conference for Phase II was held at the Resident Engineer's Office on 7 July, 1977. The topics discussed were: general administrative policies, safety plan, job hazard analysis, quality control, environmental control plans, and labor relations. Changes from the Phase I contract administration were also discussed.

3-02 Mobilization. With the exception of the construction of the Phase II work platform, the mobilization process was an exercise in contract administration. Upon securing permission , ICOS simply phased in the beginning work on Phase II with the remaining wall construction from Phase I.

3-03 Contractor's Organization. Construction continued under the general supervision of Mr. Antonio Paveglio as Project Manager. He remained in that position throughout the diaphragm wall construction and was relieved by Mr. Virgilio De Biasio as demobilization proceeded in the summer of 1980.

3-04 Construction Procedures. The Phase II diaphragm wall was an extension of the Phase I embankment wall landward. The construction procedure remained physically the same as in the Phase I contract. ICOS employed their own rock drills (Hong Kong rigs) to bore the 36-inch holes in bedrock for the primary elements. The Phase I subcontractor, Drillers/Kentucky Limited, was not retained for the second contract.

The major change to the contract was the addition of retarder to the concrete mix design. This change, Modification Number 1, dated 28 April, 1978, resulted in better concrete quality in the primary elements, in which problems were still being experienced. See concrete core log summaries in Appendix D for comparisons of concrete cores before and after the addition of this admixture, Master Builders 300R.

As in Phase I, several elements had to be deepened to satisfy the specified ten foot embedment into good rock. There were 10 elements in all which were excavated below grade for this reason and are described below.

P-821 was excavated to elevation 556.5 (design grade 560) as a result of weathered material being found at elevation 568.5 to 566.5. The adjacent elements P-819 and S-820 were also deepened, (P-819 to allow for the deepening of S-820), although no weathered material was discovered in their excavations.

P-945 was deepened from elevation 600 to elevation 593.5 due to weathered material being logged between elevation 605.7 and 604.3. Subsequently, adjacent elements S-942, P-943, S-944, S946, and P-947 were also deepened.

P-975 was taken ten feet deeper than designed as a result of weathered material in the drill cuttings between elevations 602.5 to 600.5. This element was deepened to elevation 590.0. The adjacent primary elements of P-973 and P-977 had previously been installed to the design elevation of 600.0, thus secondary elements of S-974 and S-976 could not be extended beyond the designed depth. A modification was written to core drill the bedrock beneath elevation 600.0 in those secondaries to verify the rock quality. No deleterious material was found.

3-05 Problems During Construction.

3-05.1 General. Most of the minor problems inherent at the beginning of new construction projects had been worked through by the end of Phase I, and by virtue of retaining the same contractor, were not repeated during the phase in of the second contract. Language was seldom a problem during Phase II since more local employees had been trained as specialists and those Italian specialists remaining had become familiar with English. Weather continued to cause problems, with another unusually severe winter occurring during Phase II.

3-05.2 Concrete. Concrete quality in the primary elements, although better after the addition of retarder to the mix design, was not of an outstanding nature. Placement procedures were studied and a number of tests and observations were conducted concerning leaking tremie pipe, concrete water bleed, water drawdown during rise of tremie pipe, rate of tremie pipe pull, rate of concrete rise, and concrete consolidation. Results of concrete test coring and an analysis and conclusions from the tests and observations are included in appendix...

3-05.3 Element P-653. ICOS discovered that the verticality of this element was significantly out of tolerance at the founding elevation of 560 MSL (depth 212.5), and were unsuccessful using the established procedure of reaming. They attempted a redrill after backfilling the hole to top of rock (depth 180.4) with crushed limestone, but a recheck of the verticality revealed that the bottom of the hole was still out of tolerance. The contractor once again backfilled the hole to near top of rock with crushed limestone and set 20-inch casing to align drilling action which proceeded with an

18-inch bit to 215 feet. This pilot hole allowed the redrill, in which a 30-inch bit was used, to remain straight. The contractor drilled the 30-inch hole to 215 feet, 2.5 feet lower than grade, to avoid having to first backfill the deeper pilot hole with structural grout or concrete before setting the permanent casing.

3-05.4 Landward Termination of Wall. The contract payline terminated at station 57+49.3L, in panel P-1097. Dam sections indicated a possible soft zone in this area between elevations 649.5 and 634.5 and it was proposed to extend contract requirement to add two elements to ensure closure in sound material. However, a modification was written to allow exploration by the contractor before adding the elements. Two core holes were drilled on 4.5 foot centers beyond P-1097, washboring to elevation 657, standard penetration test to top of rock, and NQ core to design depth. No soft zone was discovered in the borings and the wall was not extended.

SECTION 4 INSPECTION

4-01 Contract Administration. This contract was administered by the U.S. Army Corps of Engineers District, Nashville, Tennessee, and was executed under District Engineers Colonels Robert K. Tenner and Lee W. Tucker.

4-02 Personnel. Inspection in accordance with paragraph G.P.50 of the general provisions was performed under direct supervision of Mr. Joseph R. Turner until his transfer in May of 1979. The contract work was completed under the supervision of Mr. Duane A Dyer. See Phase I completion section, Table 6-1 for a list of personnel and their effective dates.

4-03 Final Inspection. ICOS completed the last element in the diaphragm wall of 5 September, 1979, and removal of the work platform began immediately. ICOS' subcontractor E. Randle Company began removing that portion of the work platform from Phase I that was left in place under a modification and was incorporated into the Phase II work area. The rockfill for the platform was hauled to the designated spoil area just upstream of the east abutment of the dam. The rock was put to good use in the construction of a large parking area and a launching ramp into Lake Cumberland.

The actual final inspection for both Phase I (DACW62-75-C-206) and Phase II (DACW62-77-C-0129) was held on 19 August, 1980. Representation of the District Office, the Wolf Creek Resident Office and ICOS performed the inspection.

SECTION 5 POSSIBLE FUTURE PROBLEMS

As concluded in the Phase I report, the most likely location for renewed piping would be around the landward terminus of the diaphragm wall, although it is theoretically possible for seepage to

occur at any location below piezometric gradient. Instrumentation will be vigilantly monitored, and on site personnel have on-going training for hazards recognition, reporting, and action.

REFERENCES AND RELATED READING

1. Completion Report, Volume One, Construction of Wolf Creek Dam, Access Roads, and Powerhouse Substructure, U.S. Army Corps of Engineers, Nashville, Tenn., Jan., 1952.

2. Couch, F.B., Jr., "Foundation Seepage Problems at Wolf Creek Dam", Proceeding, Eighth Ohio River Valley Soils Seminar, Louisville, Ky., Oct., 1977.

3. Couch, F.B., Jr., and Ressi diCervia, Arturo L., "Seepage Cutoff Walls Installed Through Dam is Construction First", Civil Engineering-ASCE, pp. 62-66, Jan., 1979.

4. Fetzer, Claude A., "Wolf Creek Dam - Remedial Work", presented as Q.49, R.5 at 13th Congress on Large Dams, New Delhi, India, 1979.

5. Holland, T.C., and Turner, J.R., Construction of Tremie Concrete Cutoff Wall, Wolf Creek Dam, Kentucky, U.S. Army Engineer Waterways Experiment Station, Sept., 1980.

6. Kellberg, J., and Simmons, M., "Geology of the Cumberland River Basin and the Wolf Creek Damsite, Kentucky", The Bulletin of the Association of Engineeting Geologists, Vol. 14, No.4, 1977.

7. Report of Analysis of Safety, Earth Embankment, Wolf Creek Dam, U.S. Army Corps of Engineers, Nashville District, Nashville, Tenn., 1973.

8. Report of Remedial Work 1968-1970, Earth Embankment, Wolf Creek Dam, U.S. Army Corps of Engineers, Nashville District, Nashville, Tenn.,1972.

9. Report of Subsurface Investigations, Completion of Phase I, Wolf Creek Dam, U.S. Corps of Engineers, Nashville District, Nashville, Tenn., 1974.

10. Report of Subsurface Investigations, Completion of Phase II, Wolf Creek Dam, U.S. Army Corps of Engineers, Nashville District, Nashville Tenn., 1974.

11. Report of Subsurface Investigations, Completion of Phase III, Wolf Creek Dam, U.S. Army Corps of Engineers, Nashville District, Nashville Tenn., 1975.

12. Simmons, M.D., "Remedial Treatment Exploration, Wolf Creek Dam, Ky.", Journal of the Geotechnical Engineering Division, Proceedings of the American Society of Civil Engineers, Vol. 108, No. GT7, July, 1982.

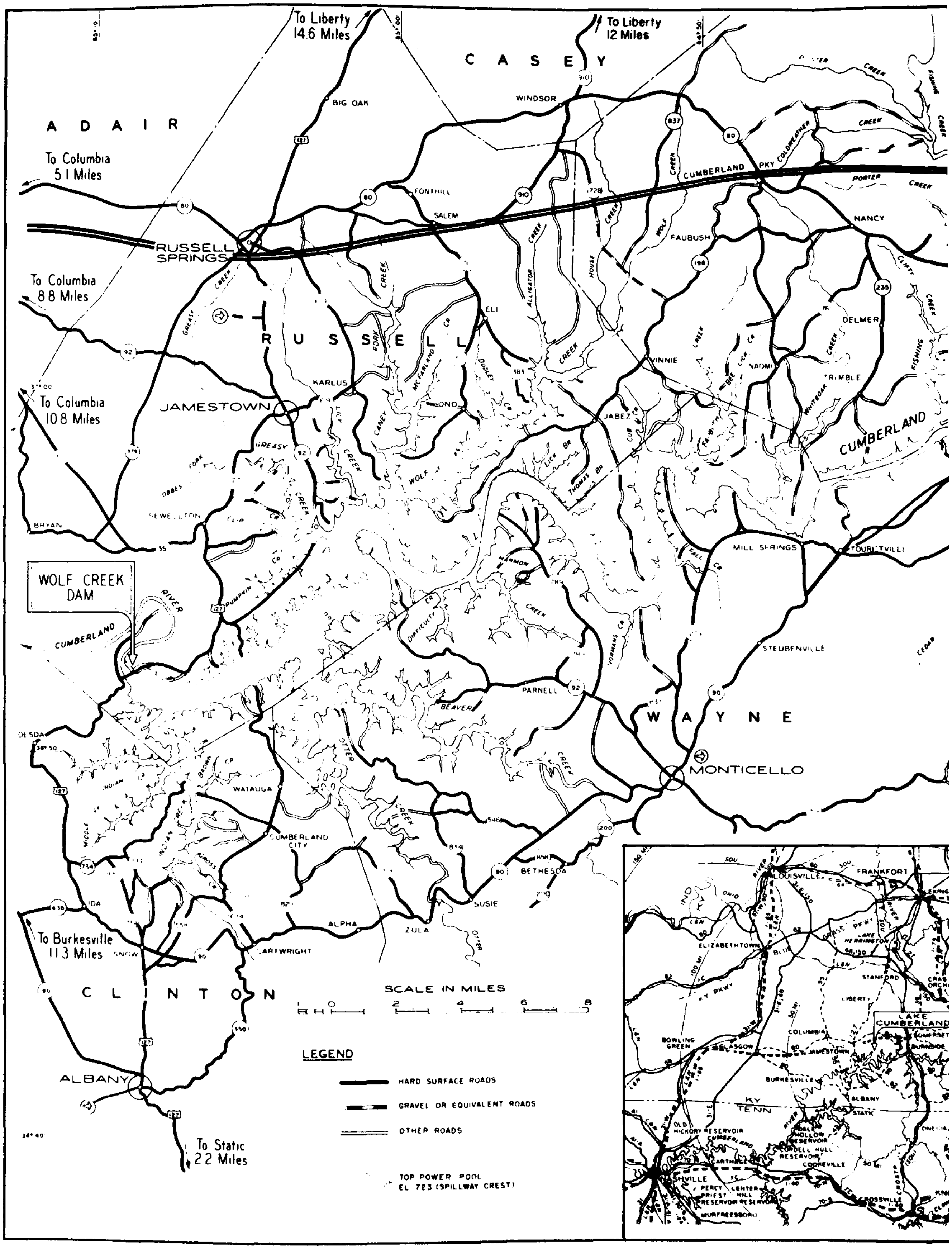
13. Specifications for Construction of Concrete Diaphragm Walls, Contract No. DACW 62-75-C-0206, U.S. Army Corps of Engineers, Nashville District, Nashville, Tenn., 1975.

14. Specifications for Construction of Concrete Diaphragm Wall, Phase II, Contract No. DACW 62-77-C-0129, U.S. Army Corps of Engineers, Nashville District, Nashville, Tenn., 1977.

15. Wolf Creek Dam, Design Memorandum No. 1, Concrete Diaphragm Walls, U.S. Army Corps of Engineers, Nashville District, Nashville, Tenn., 1974.

APPENDIX A

CONTRACT DRAWINGS



To Liberty 14.6 Miles
To Liberty 12 Miles
CASEY
ADAIR
To Columbia 5.1 Miles
To Columbia 8.8 Miles
To Columbia 10.8 Miles
BIG OAK
WINDSOR
FONTHILL
SALEM
CUMBERLAND PKY
FAUBUSH
NANCY
DELMER
RUSSELL SPRINGS
RUSSELL
ELI
KARLUS
JAMESTOWN
ONO
JABEZ
VINNIE
NAOMI
TRIMBLE
CUMBERLAND
BRYAN
SEWELLTON
MILL SPRINGS
WOLF CREEK DAM
CUMBERLAND RIVER
STEUBENVILLE
PARNELL
WAYNE
MONTICELLO
DE SODA
WATAUGA
CUMBERLAND CITY
BETHESDA
SUSIE
ALPHA
ZULA
IDA
CARTWRIGHT
To Burkesville 11.3 Miles
SNOW
CLINTON
SCALE IN MILES
0 2 4 6 8
LEGEND
HARD SURFACE ROADS
GRAVEL OR EQUIVALENT ROADS
OTHER ROADS
ALBANY
To Static 22 Miles
TOP POWER POOL
EL 723 (SPILLWAY CREST)
LOUISVILLE
FRANKFORT
ELIZABETHTOWN
STANFORD
LIBERTY
BOWLING GREEN
GLASGOW
COLUMBIA
JAMESTOWN
LAKE CUMBERLAND
BURKESVILLE
ALBANY
KY
TENN
CARTHAGE
MURFREESBORO

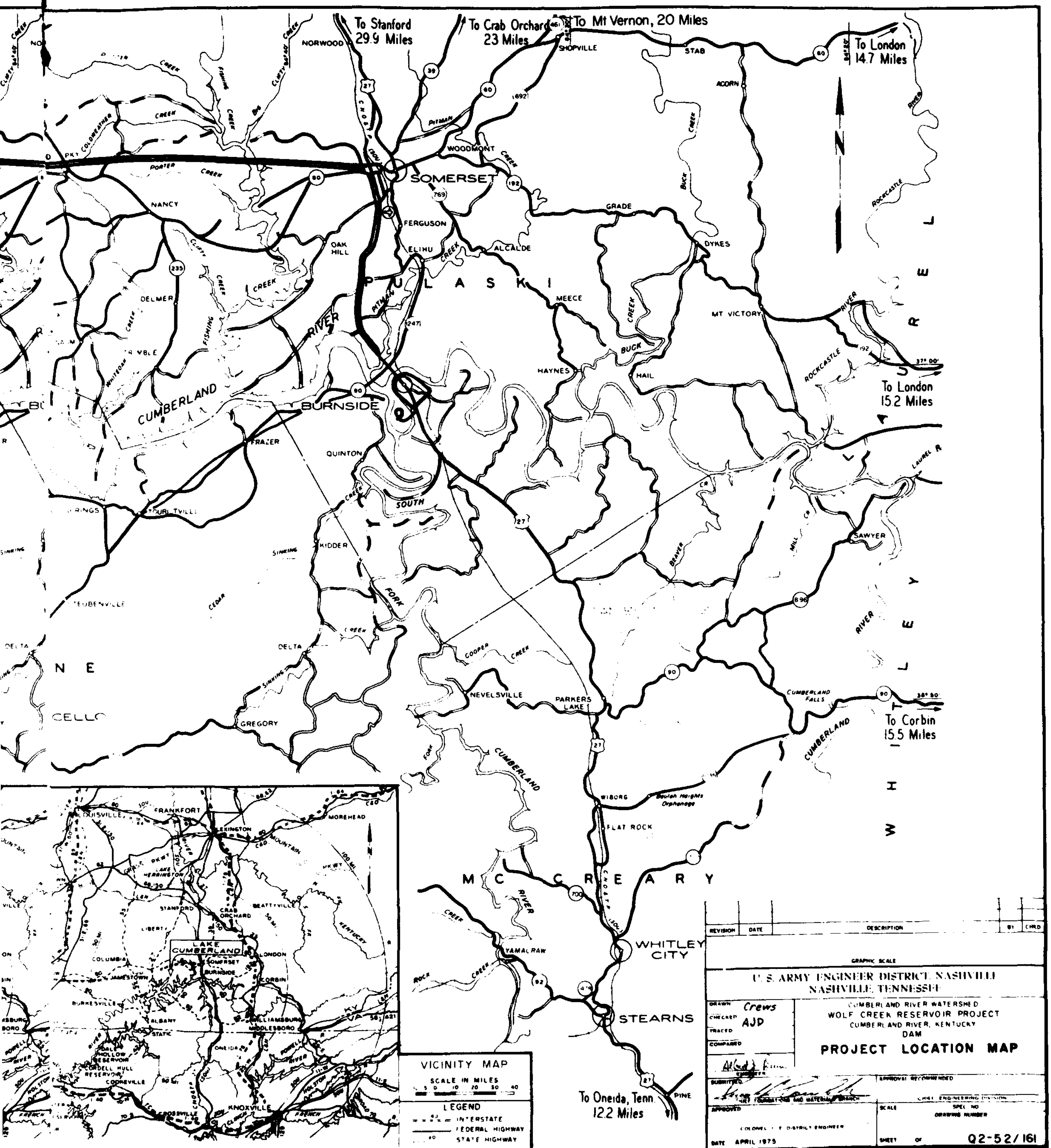
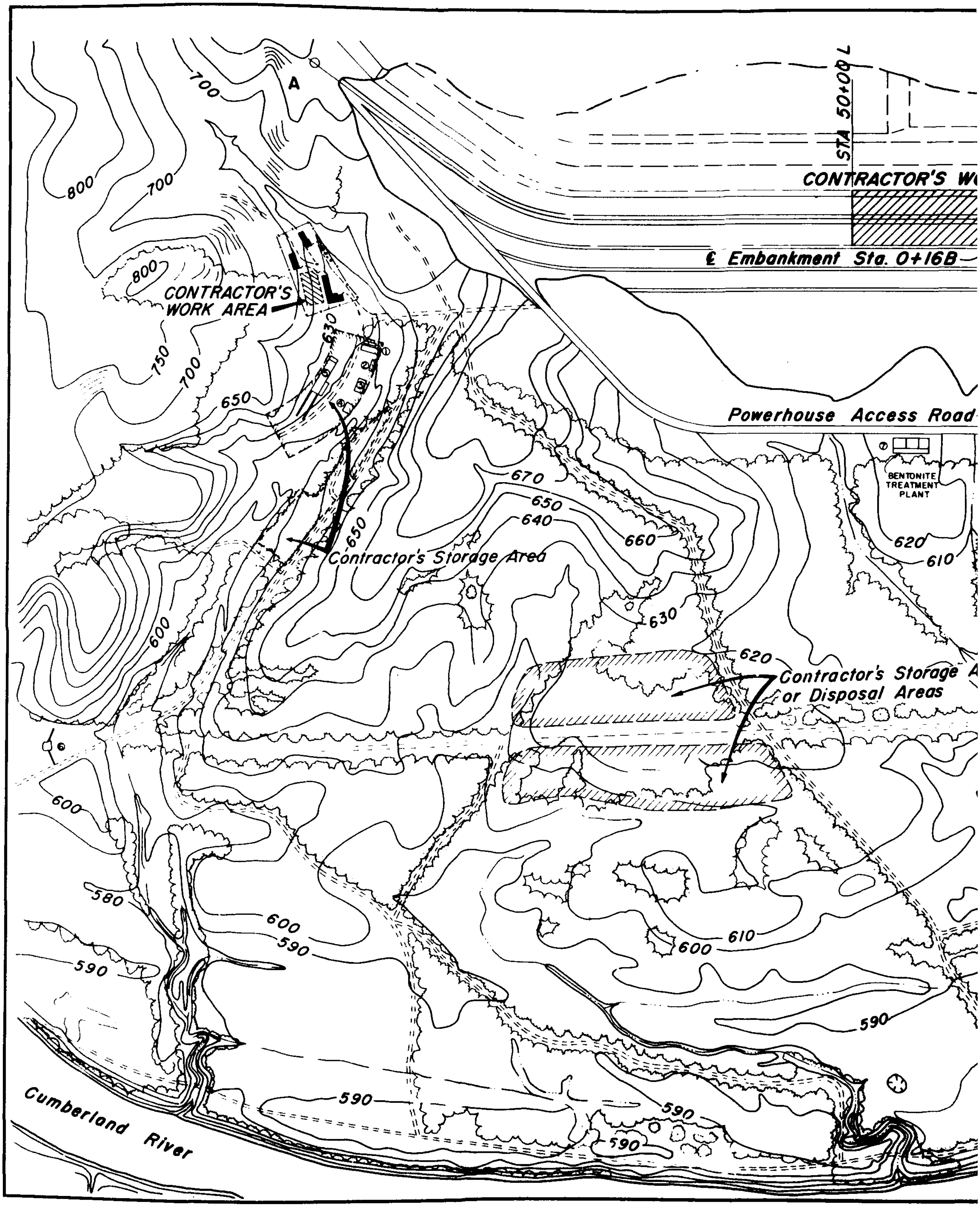


PLATE A-1 Dinna A Dyer 7 May 1981



STA 50+00 L
CONTRACTOR'S W
℄ Embankment Sta. 0+16B
CONTRACTOR'S WORK AREA
Powerhouse Access Road
BENTONITE TREATMENT PLANT
Contractor's Storage Area
Contractor's Storage A
or Disposal Areas
Cumberland River
A
800
750
700
670
660
650
640
630
620
610
600
590
580

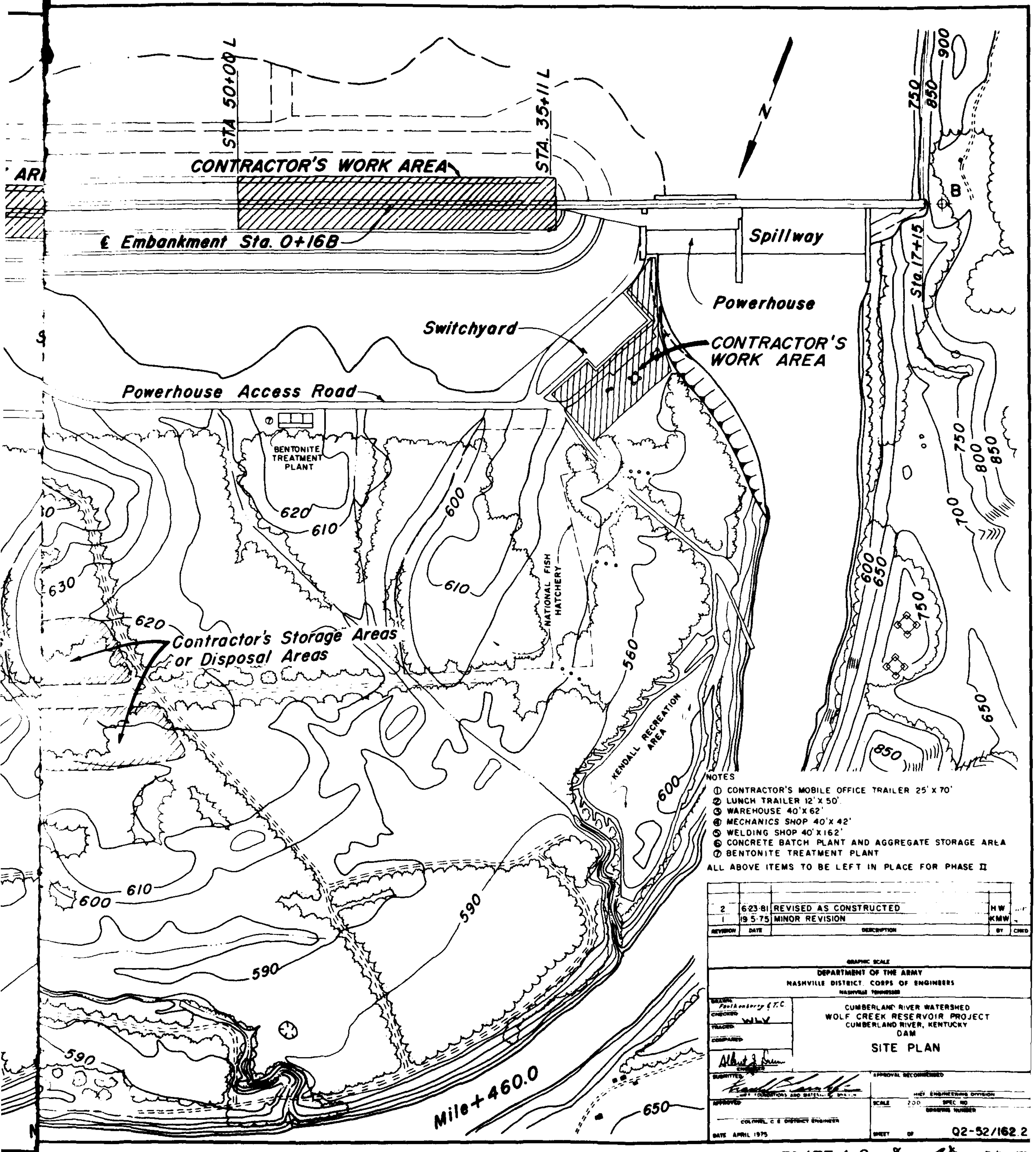
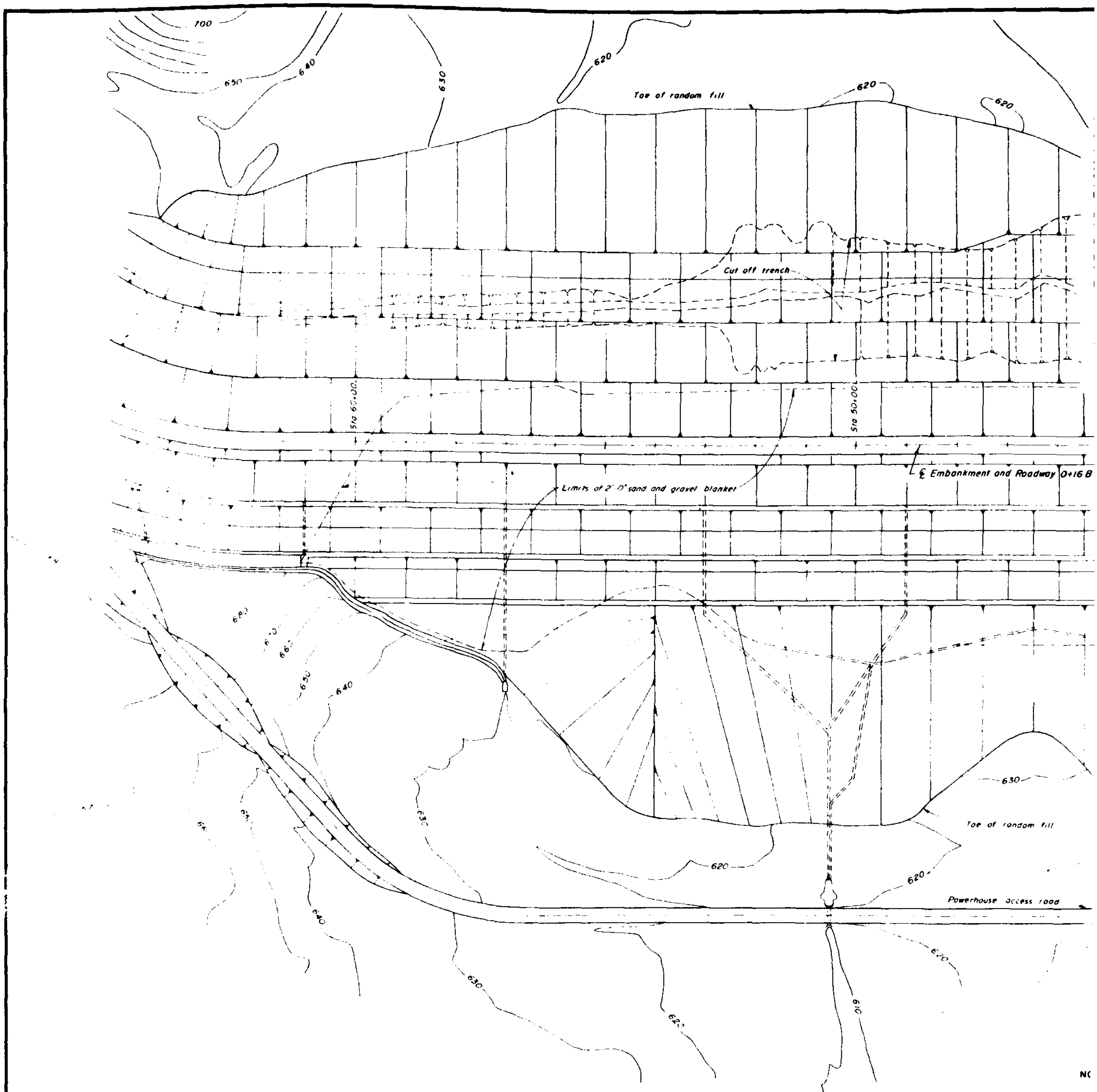
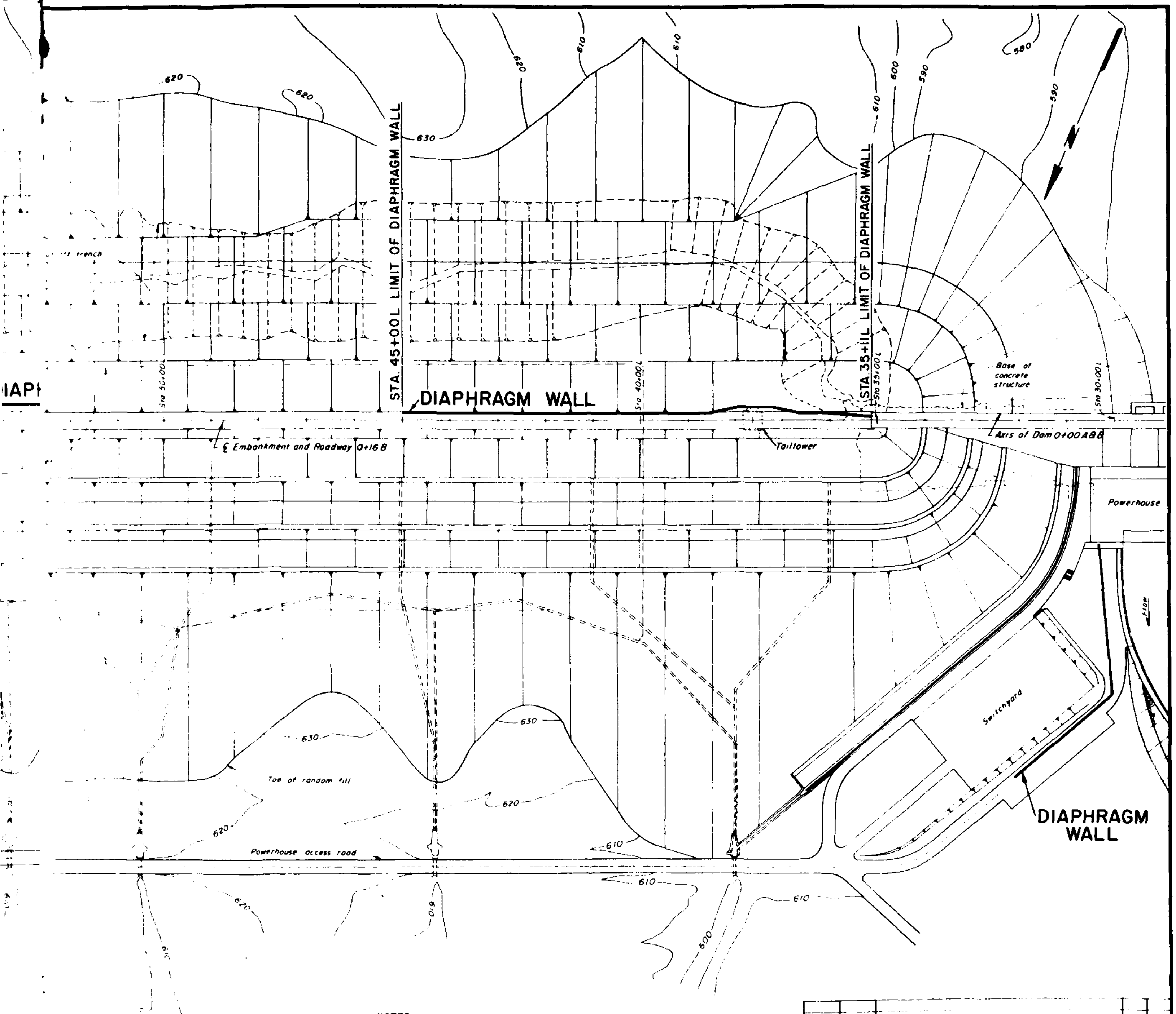


PLATE A-2 Duane A. Dyer 7 May 1981



Toe of random fill
Cut off trench
Sta 60+00
Sta 50+00
℄ Embankment and Roadway 0+16 8
Limits of 2'0" sand and gravel blanket
Toe of random fill
Powerhouse access road
700
650
640
630
620
610

PLAN



PLAN

NOTES

1. For Plan and Profile Along Embankment Diaphragm Wall see Dwgs Q2-52/164 and /165
2. For Section of Embankment Diaphragm Wall see Dwg. Q2-52/167
3. For Plan of Explorations, see Dwg. Q2-52/186, /187 and 189
4. For Geologic Sections Along Diaphragm Wall Alignment see Dwg. Q2-52/190 through /194 and /199 through /201
5. For Plan of Instrumentation see Dwg. Q2-52/206
6. For Plan and Sections of Switchyard Wall see Dwg. Q2-52/168
7. All elevations are Mean Sea Level, Sandy Hook Datum.
5. For site restoration, see specifications

REVISION	DATE	DESCRIPTION	BY	CHKD.

100' 0 100' 200'
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN: M R D R R
CHECKED: W L Y
TRACED:
COMPARED:

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
GENERAL PLAN
CONCRETE DIAPHRAGM WALLS

SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH

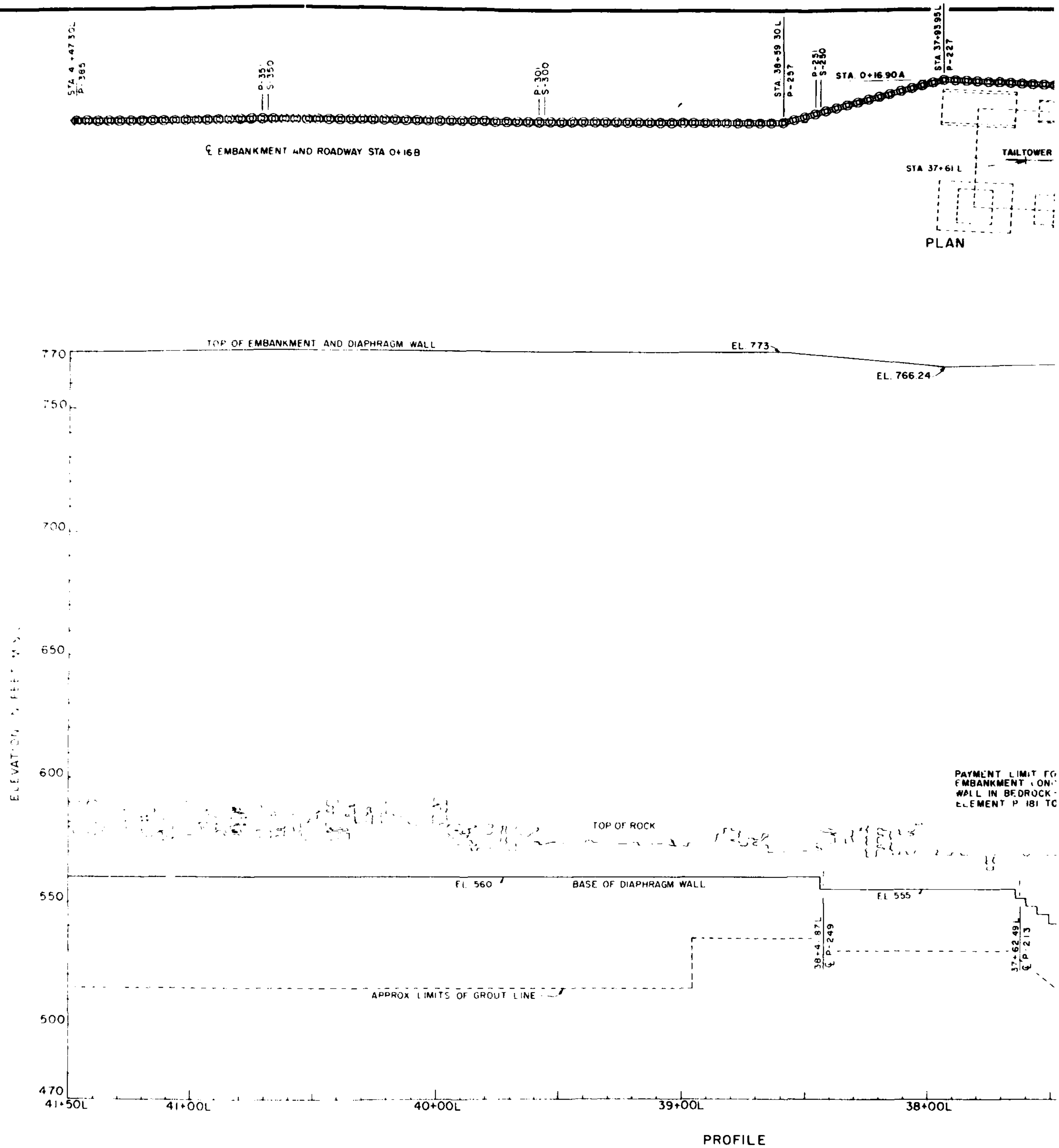
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION

APPROVED: COLONEL, C. E. DISTRICT ENGINEER

SCALE: 1" = 100'
DATE: APRIL 1975
SHEET OF
Q2-52/163

RECORD DRAWING AS CONSTRUCTED DATED 7 May 1981

PLATE A 3

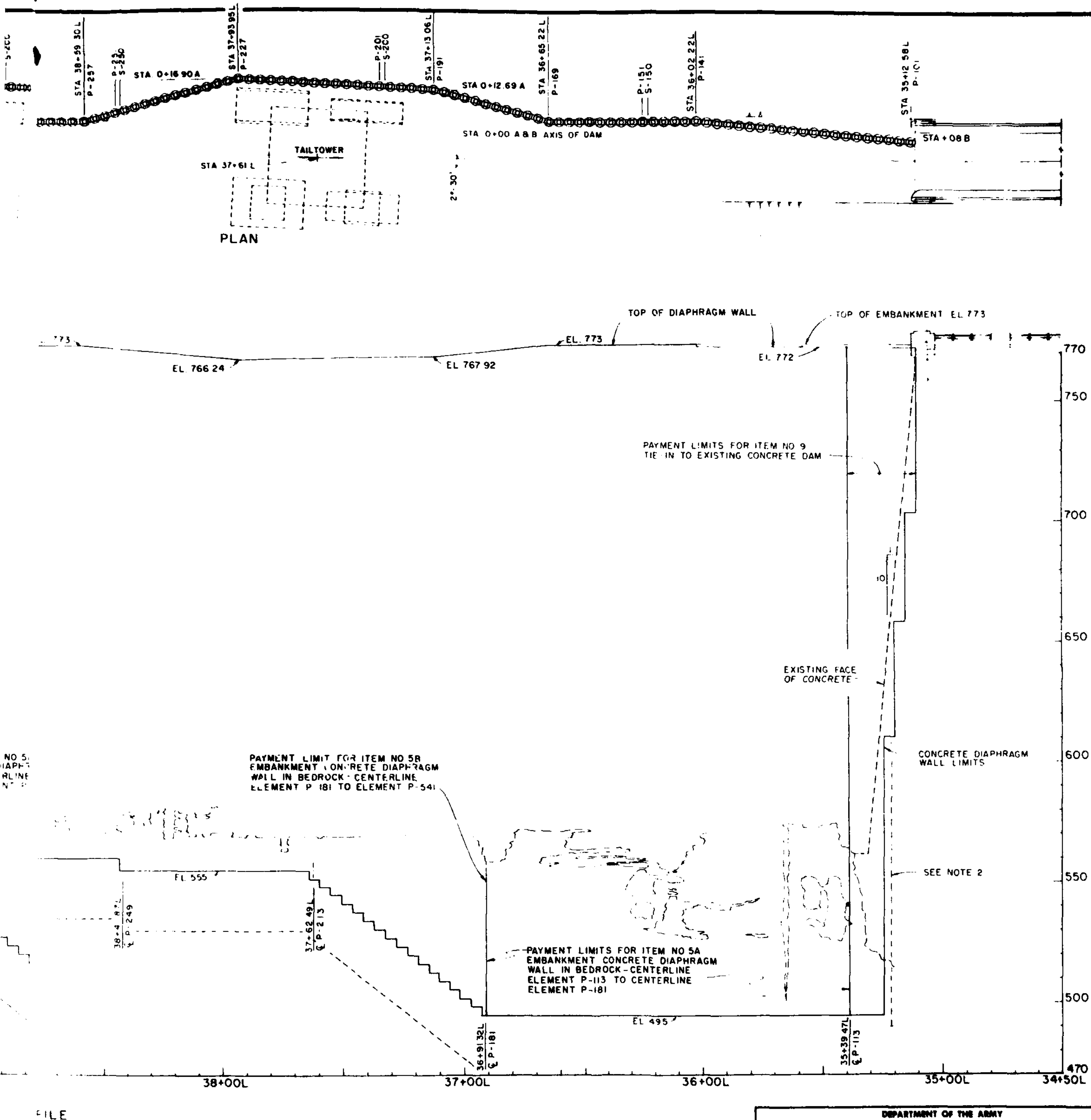


LEGEND

S-102 SECONDARY ELEMENT (EVEN NUMBERS)
P-101 PRIMARY ELEMENT (ODD NUMBERS)

GENERAL NOTES

1. *For Geologic Sections along diaphragm wall alignment, see Dwg Q2-52/190 through Q2 52/*
2. *NQ core hole from bottom of P-105 will be drill to elevation 490*
3. *NQ core holes from bottom of P-107 through P- will be drilled to elevation 470 All remaining to be drilled to elevations indicated or as di by the Contracting Officer*



GENERAL NOTES

1. *For Geologic Sections along diaphragm wall alignment, see Dwg Q2-52/190 through Q2-52/198*
2. *NQ core hole from bottom of P-105 will be drilled to elevation 490*
3. *NQ core holes from bottom of P-107 through P-181 will be drilled to elevation 470. All remaining holes to be drilled to elevations indicated or as directed by the Contracting Officer*

REVISION	DATE	DESCRIPTION	BY	CHKD
2	8-22-75	REALIGNMENT OF DIAPHRAGM WALL STA 36+65.22 THRU STA 38+59.30 ADJUST TAILTOWER LOCATION	LJL	
1	5-19-75	MINOR REVISIONS	KMW	

20' 0 20' 40'
GRAPHIC SCALE

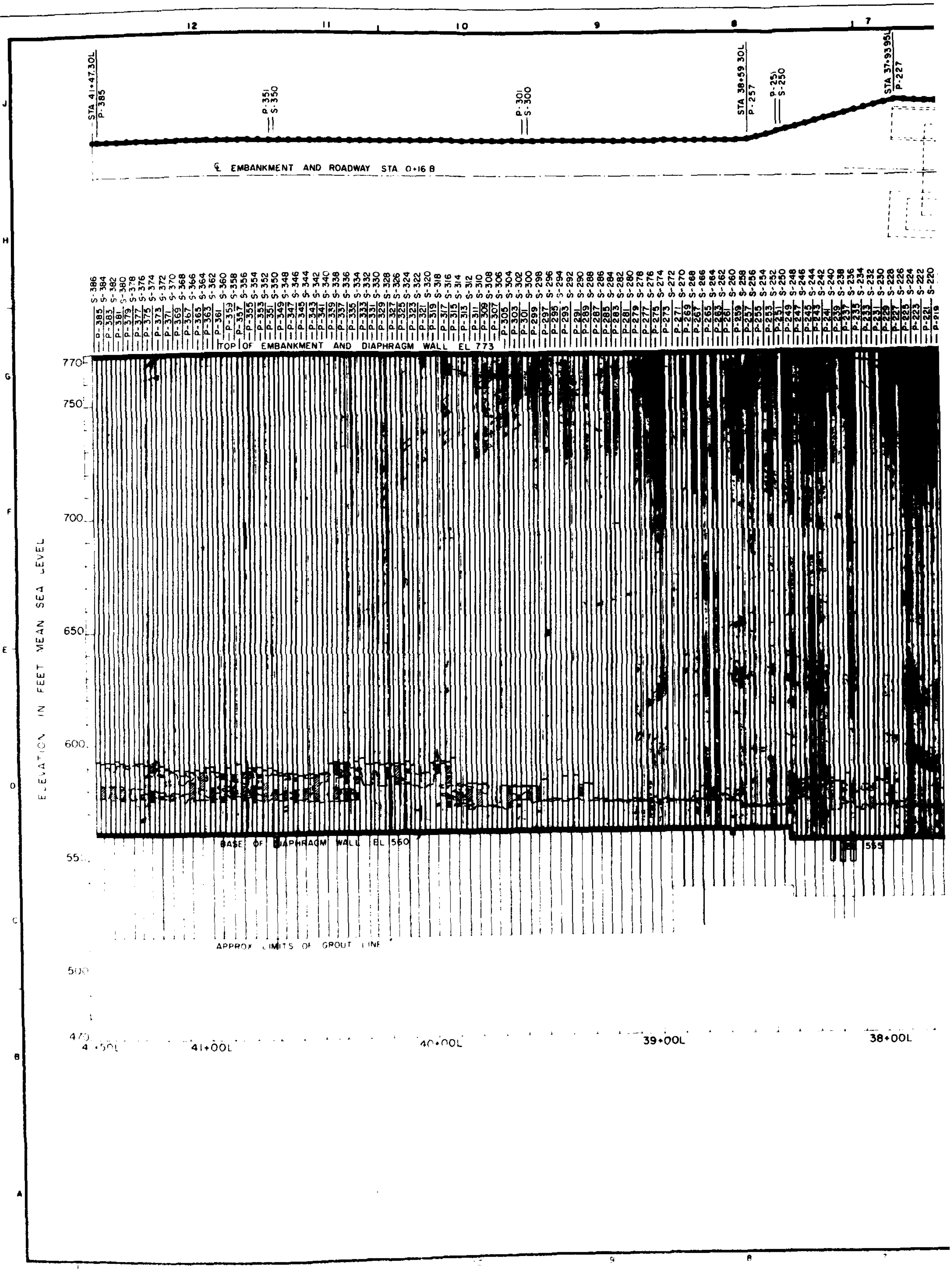
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

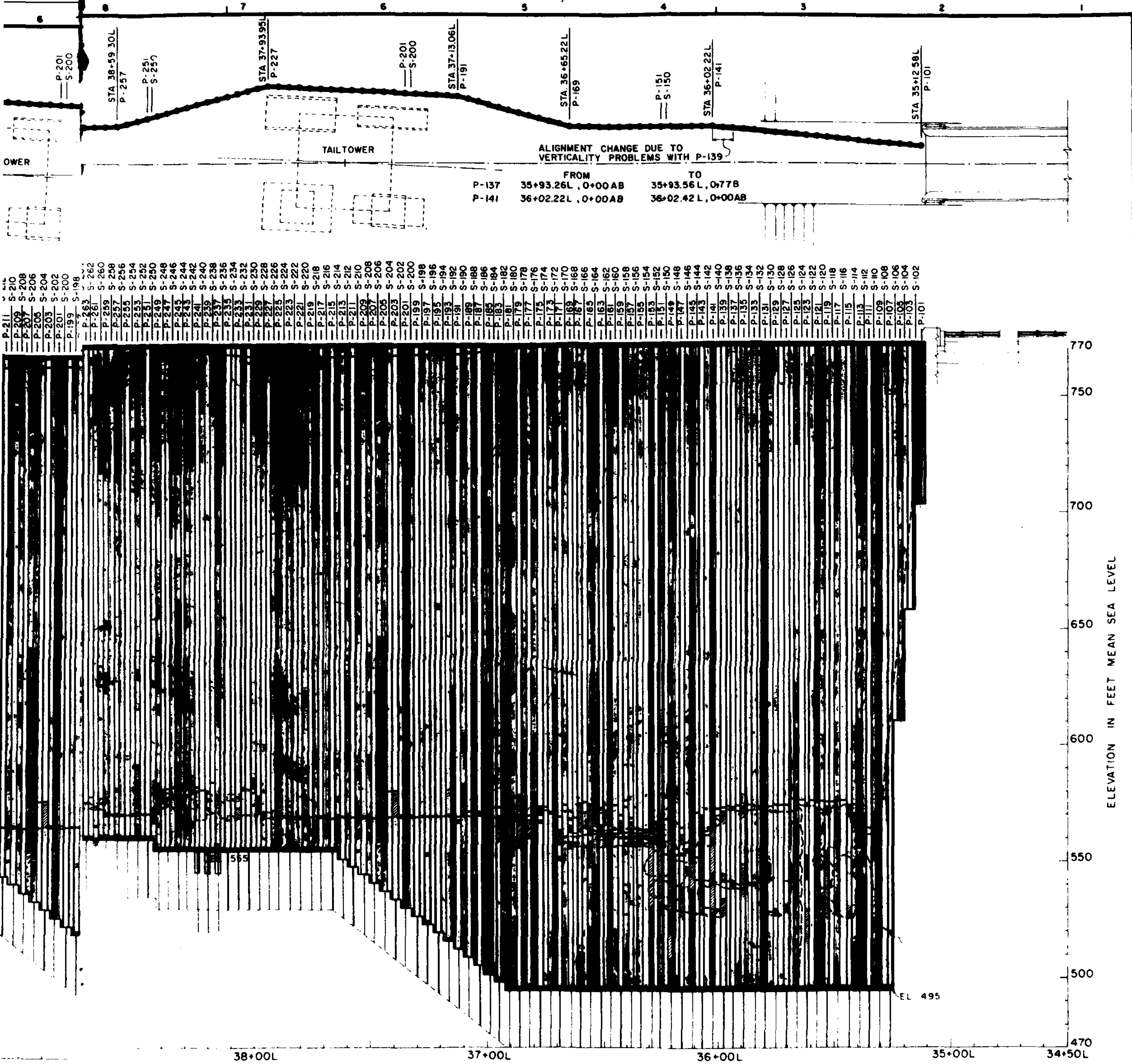
DRAWN
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
PLAN AND PROFILE (ICOS)
STA 35+11L TO STA 41+50L

SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E DISTRICT ENGINEER
DATE APRIL 1975
SCALE 1"=20'
SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/164.2

PLATE A-4


STA 41+47.30L
P-385
P-351
S-350
P-301
S-300
STA 38+59.30L
P-257
P-251
S-250
STA 37+93.95L
P-227
℄ EMBANKMENT AND ROADWAY STA 0+16 B
TOP OF EMBANKMENT AND DIAPHRAGM WALL EL 773
ELEVATION IN FEET MEAN SEA LEVEL
770
750
700
650
600
550
500
BASE OF DIAPHRAGM WALL EL 560
565
APPROX LIMITS OF GROUT LINE
41+00L
40+00L
39+00L
38+00L



LEGEND

TOP OF ROCK

CAVITY ENCOUNTERED DURING EXCAVATION

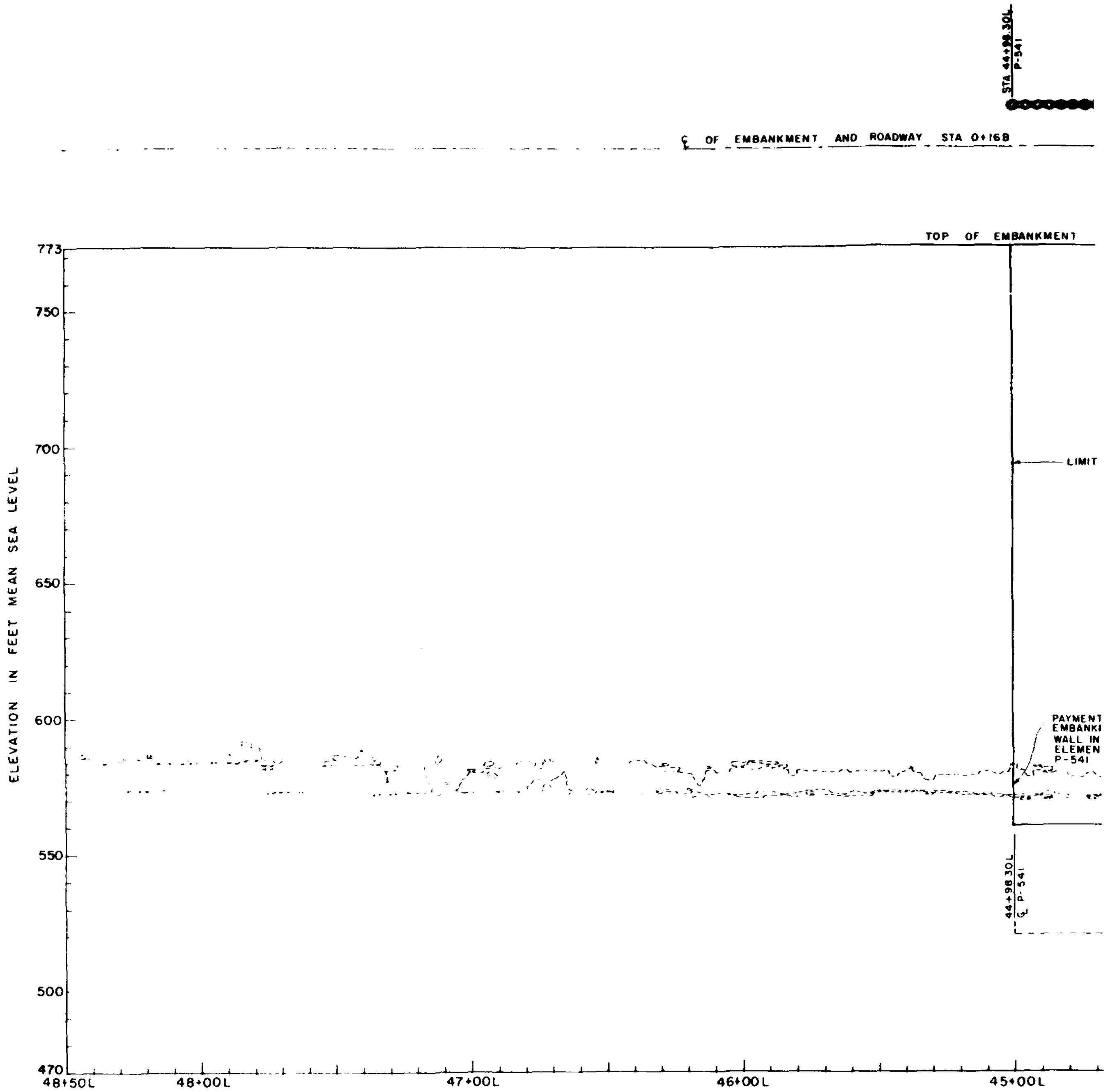
COMPLETED ELEMENT

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
SOLUTION FEATURES
STA 35+11L TO STA 41+50L

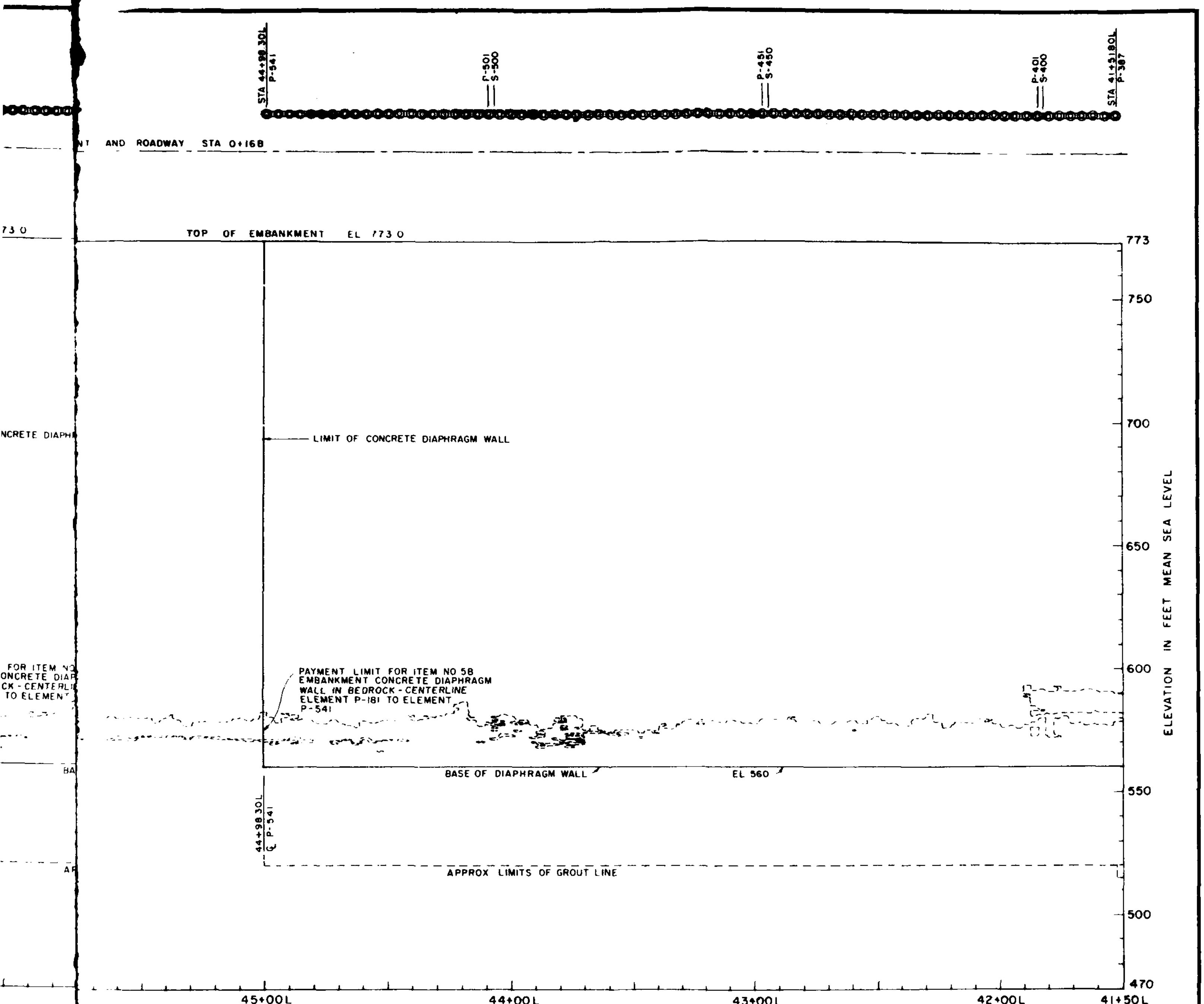
DRAWN L L
SCALE 1"=20
Q2-52/164A

PLATE A-5



STA 44+98.30L
P-541
℄ OF EMBANKMENT AND ROADWAY STA 0+16B
TOP OF EMBANKMENT
LIMIT
PAYMENT
EMBANK
WALL IN
ELEMEN
P-541
44+98.30L
℄ P-541
ELEVATION IN FEET MEAN SEA LEVEL
773
750
700
650
600
550
500
470
48+50L
48+00L
47+00L
46+00L
45+00L

PROFILE



PROFILE

NOTE
For General Notes see Dwg Q2-52/164

Revision	Date	Description	By	Chkd
1	5-19-75	MINOR REVISION	KMW	

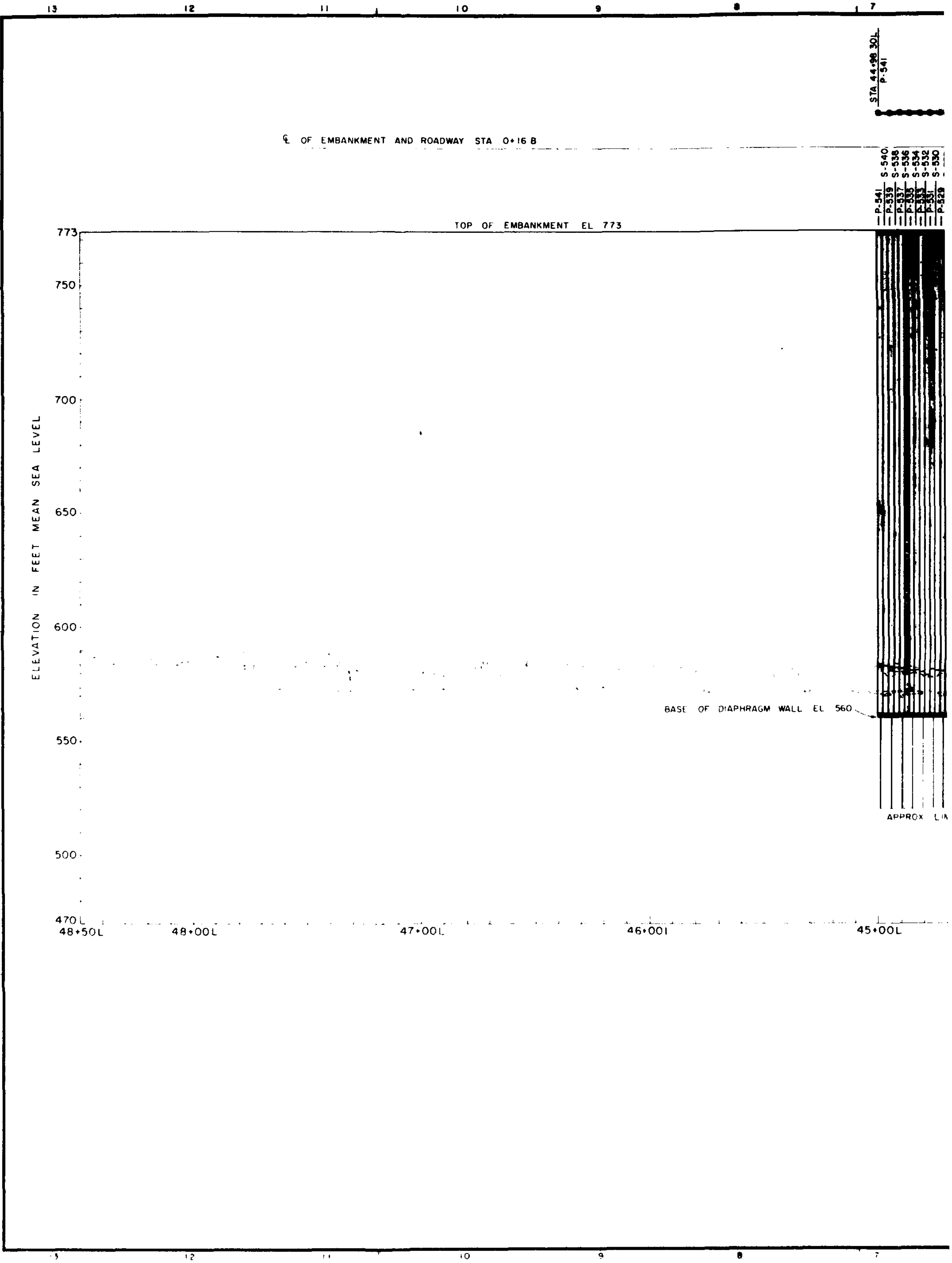
GRAPHIC SCALE: 20 0 20 40

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

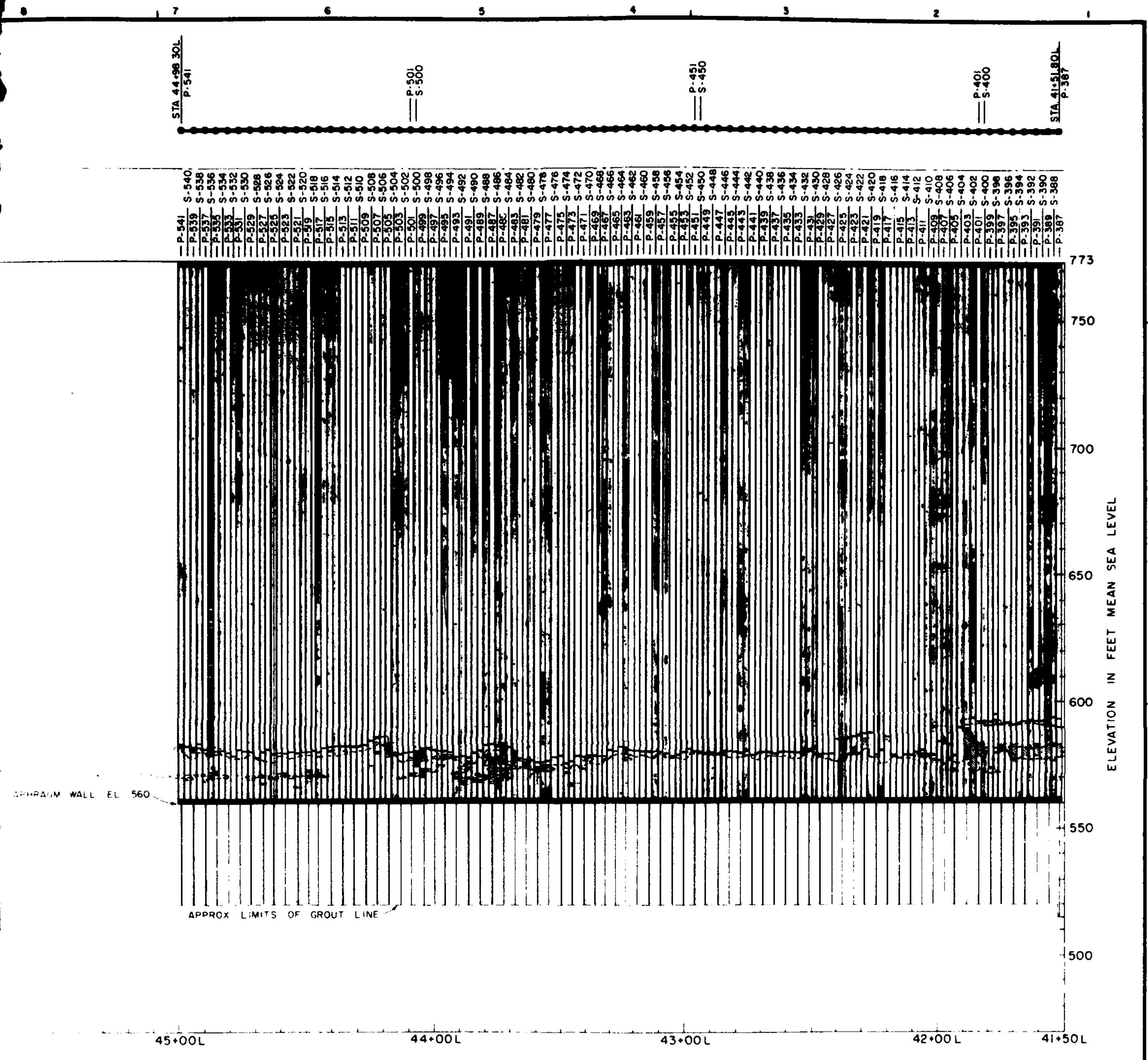
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
PLAN AND PROFILE (ICOS)
STA 41+50L TO STA 48+50L

DATE APRIL 1975
SCALE 1"=20'
Q2-52/165.1

PLATE A-6



STA 44+98 30L
P-541
℄ OF EMBANKMENT AND ROADWAY STA 0+16 B
S-540
S-538
S-536
S-534
S-532
S-530
P-541
P-539
P-537
P-535
P-533
P-531
P-529
TOP OF EMBANKMENT EL 773
773
750
700
650
600
550
500
470
ELEVATION IN FEET MEAN SEA LEVEL
BASE OF DIAPHRAGM WALL EL 560
APPROX
48+50L
48+00L
47+00L
46+00L
45+00L



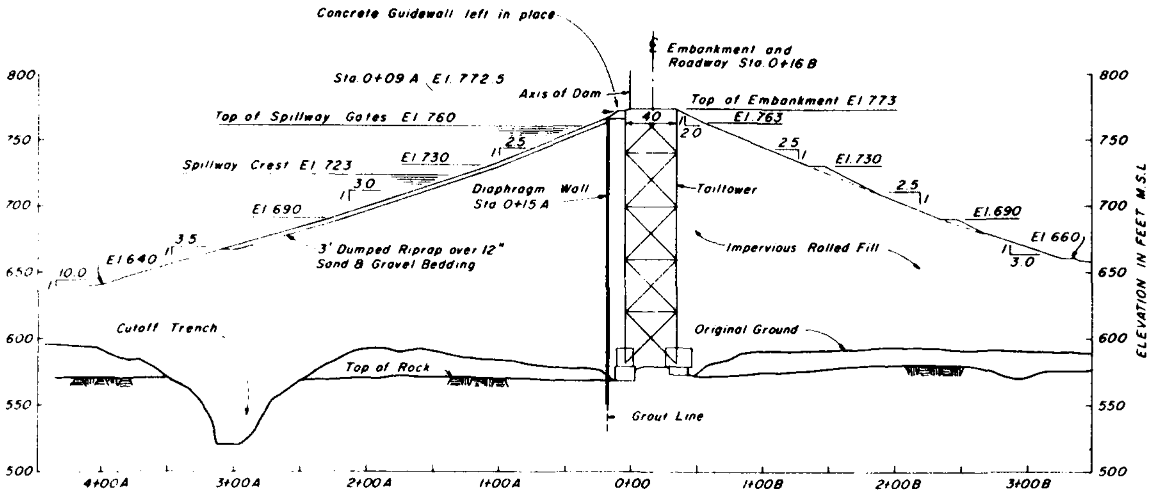
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
SOLUTION FEATURES
STA 41+50L TO STA 48+50L

DRAWN
CHECKED
TRACED
COMPARED
SUBMITTED
APPROVAL RECOMMENDED
APPROVED
DATE

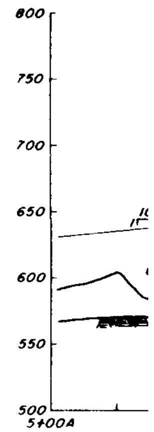
Q2-52/165A

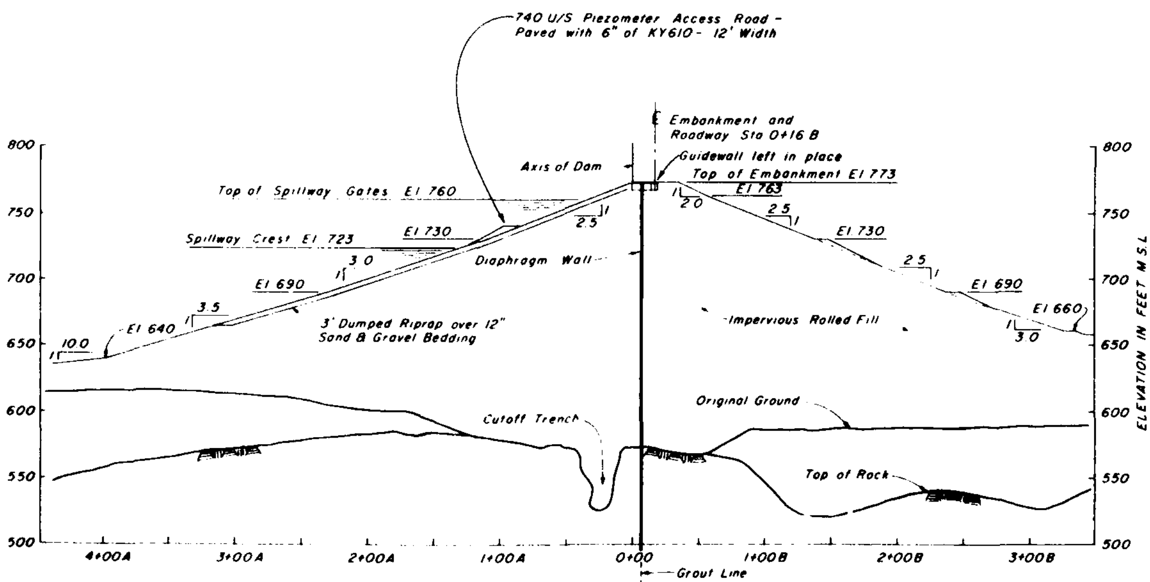
PLATE A-7



STATION 37+61 L

SCALE 1"=50'





STATION 35+56 L

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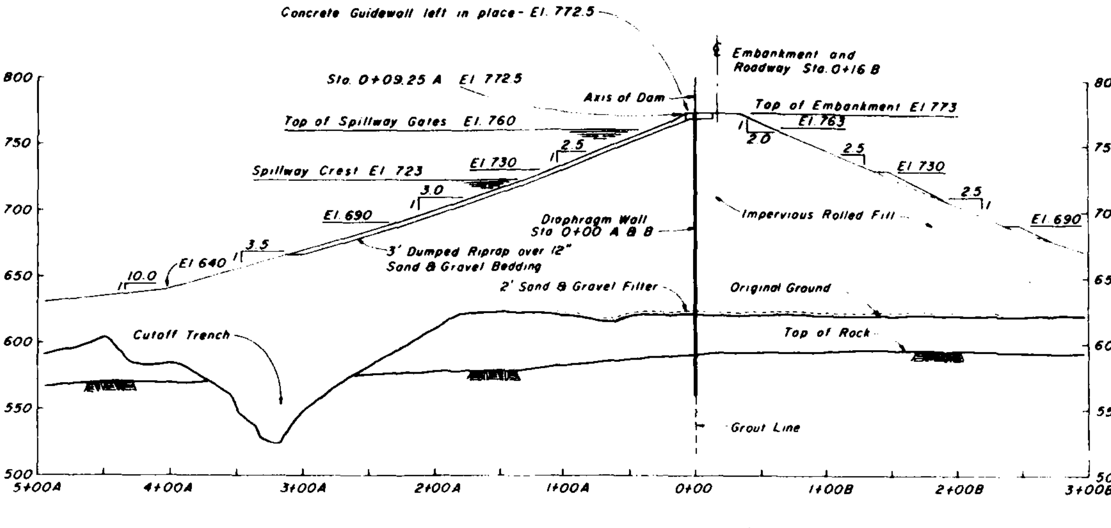

STATION 41+00L

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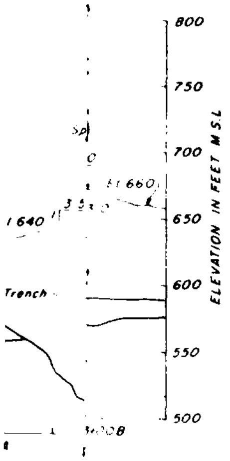
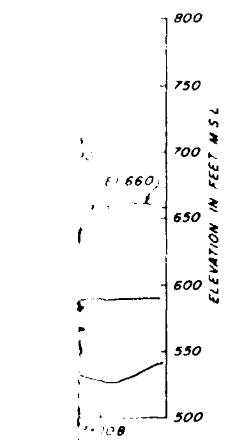




GENERAL NOTES

1. For General Plan see Dwg Q2 52/163
2. For Plan and Profile along Embankment Diaphragm Wall see Dwgs Q2-52/164 and /165

REVISION	DATE	DESCRIPTION	BY
3	8-13-81	REVISIONS AS CONSTRUCTED	MAP
2	8-25-75	REVISED TAILTOWER FOUNDATIONS	LJL
1	5-19-75	MINOR REVISIONS	KMW

50 0 50 100
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN R.K.

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
(ICOS)
SECTIONS

CHIEF, FOUNDATIONS AND MATERIALS BRANCH

CHIEF, ENGINEERING DIVISION

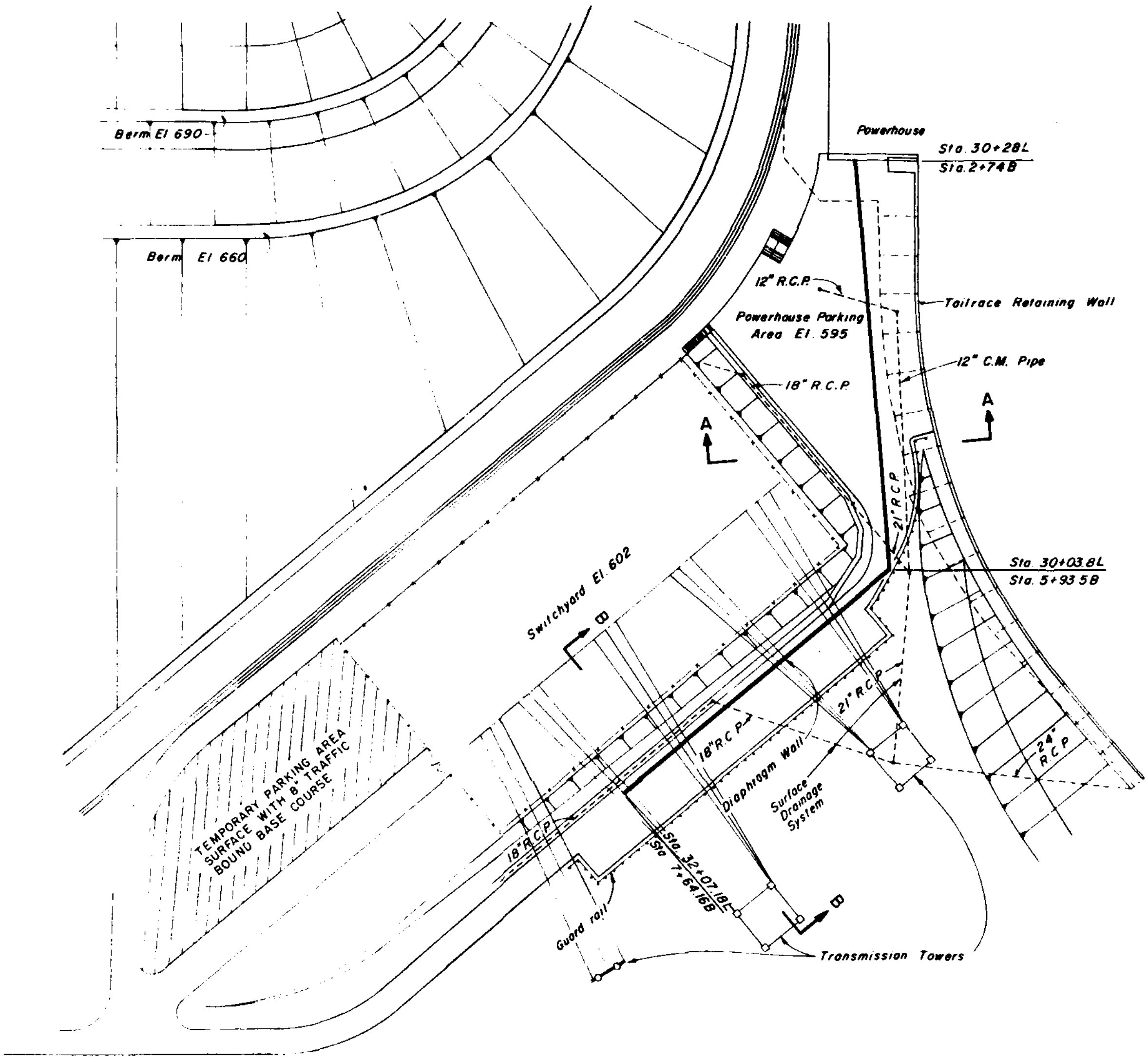
COLONEL, C.E. DISTRICT ENGINEER

SCALE AS SHOWN

DATE APRIL 1975

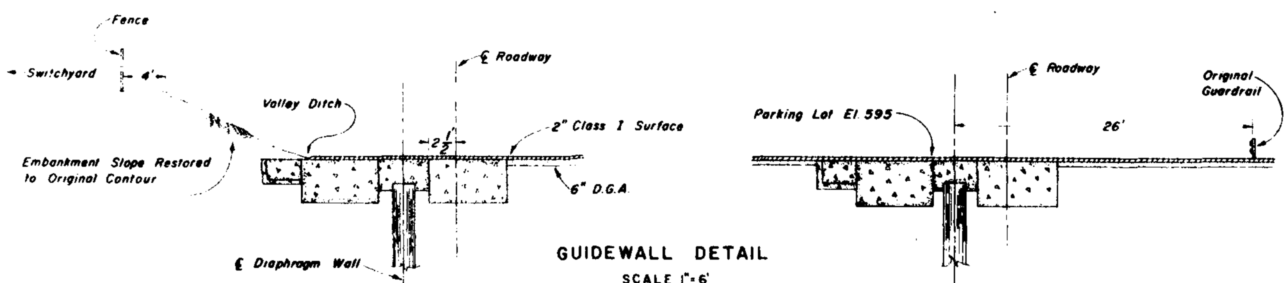
Q2-52/167.3

PLATE A-8



PLAN OF SWITCHYARD WALL

SCALE: 1" = 50'



GUIDEWALL DETAIL

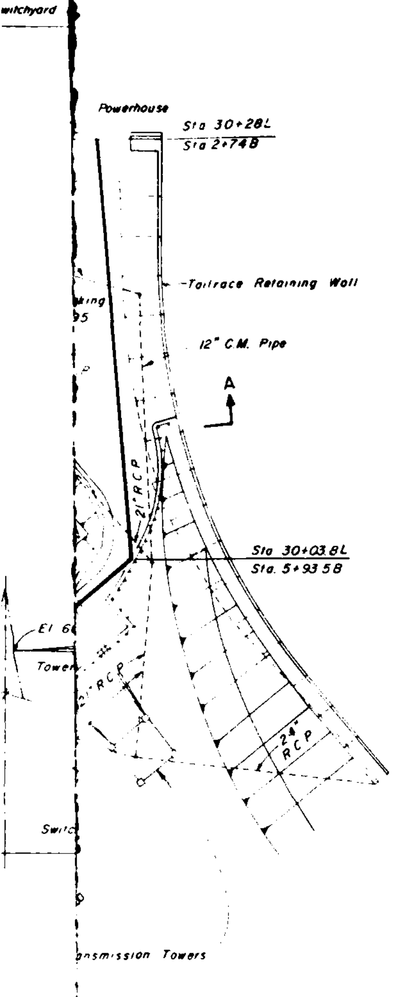
SCALE 1" = 6'

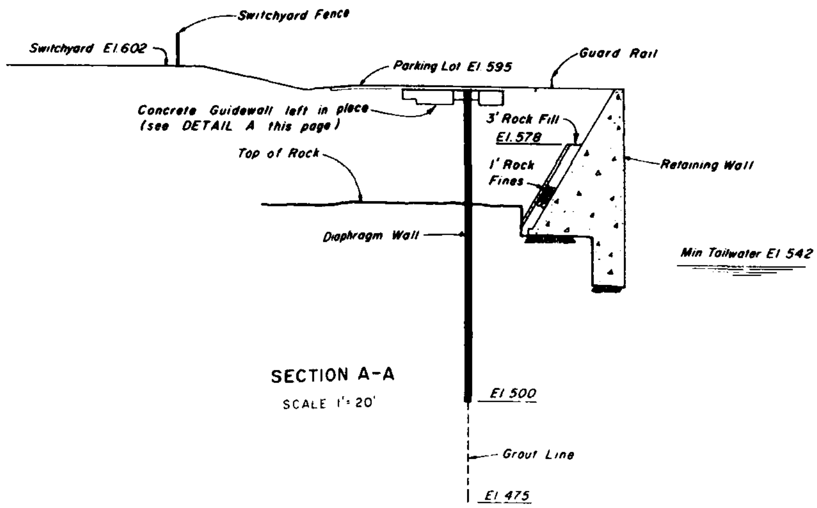
DETAIL B

DETAIL A

NOTES -

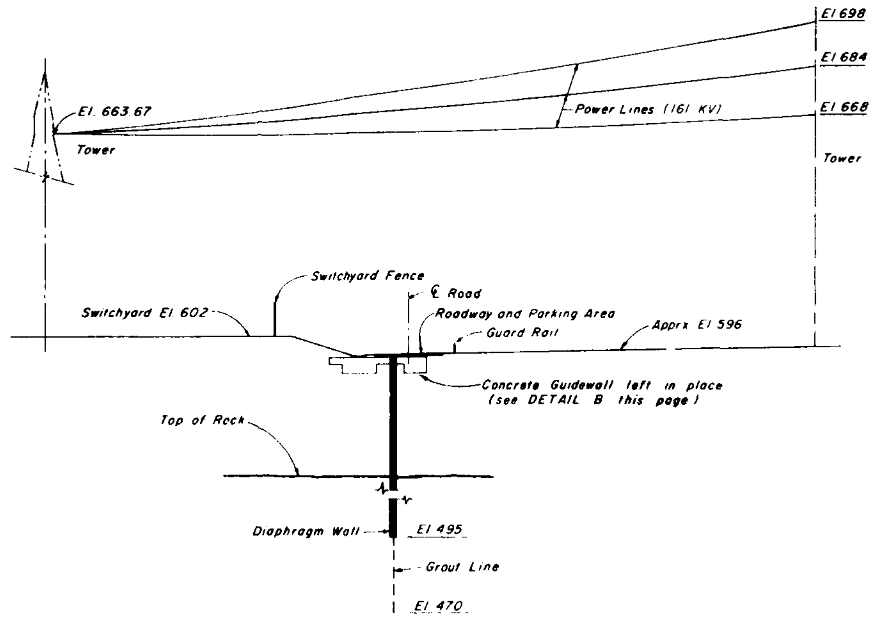
1 Guidewalls to remain in place.
2 Utility troughs to be backfilled with concrete.
3 Sub-base, 6" compacted D.G.A.
4 2" thickness asphalt surface.





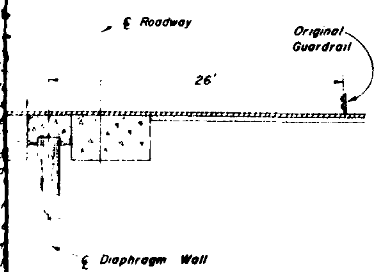
SECTION A-A

SCALE 1"=20'



SECTION B-B

SCALE 1"=20'



DETAIL A

GENERAL NOTES

1. For profile along switchyard diaphragm wall see Dwg Q2-52/169
2. For plan of explorations see Dwg Q2-52/189
3. For geoloic sections along diaphragm wall alignment, see Dwgs Q2-52/200 and Q2-52/201
4. The buried storm drain pipe shall be located in the field and provisions made to pass through a secondary wall element. The alignment may be adjusted as conditions warrent
5. For site restoration, see specifications
6. The power lines between the switchyard and the transmission towers will be raised by others to provide 80 feet clearance above the switchyard diaphragm wall. In order to facilitate the raising of these power lines, the Contractors shall provide a written notice 90 days prior to working under these power lines

REVISION	DATE	DESCRIPTION	BY	CHKD
2	8-13-81	REVISIONS AS CONSTRUCTED	MAP	
1	5-19-75	MINOR REVISION	BF	

GRAPHIC SCALE: 50' 0 50' 100'

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

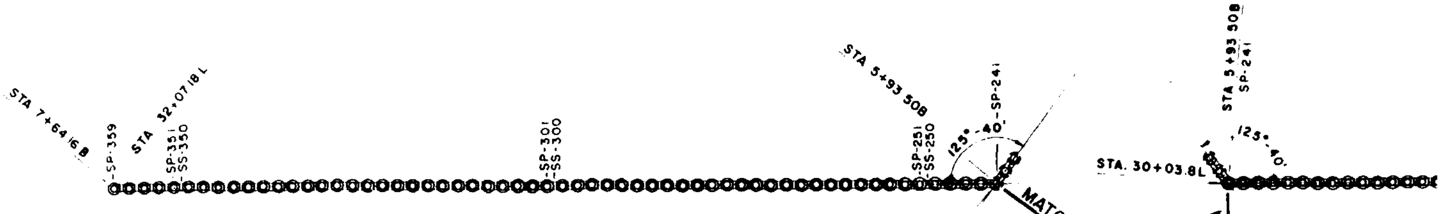
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

SWITCHYARD DIAPHRAGM WALL
PLAN AND SECTIONS (ICOS)

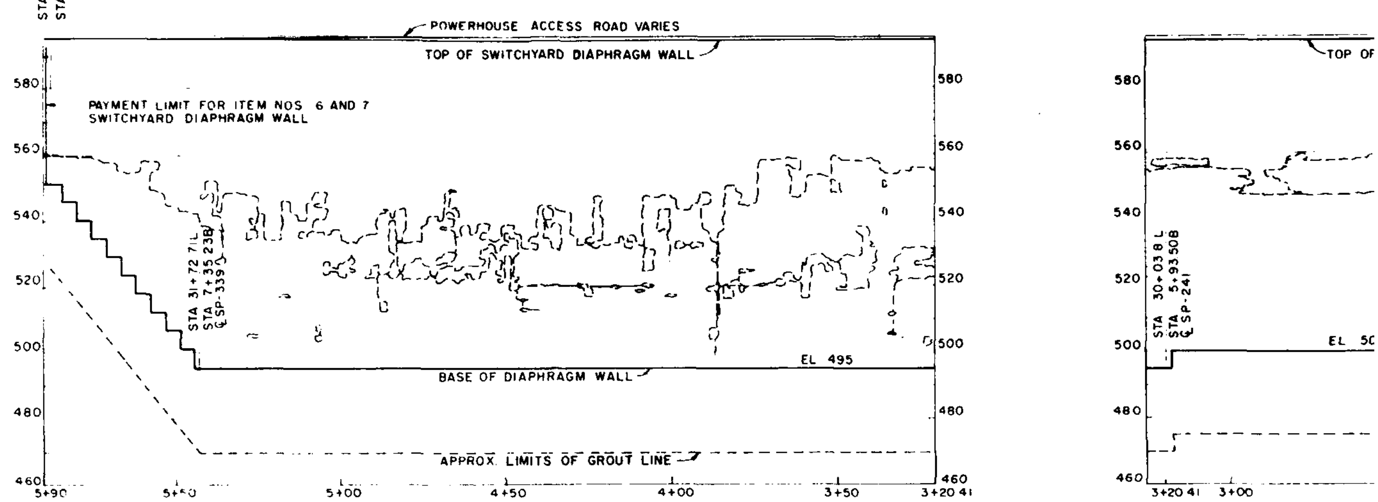
DRAWN: TC / RA
CHECKED: W.L.V.
TRACED:
COMPARED:
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
DATE: APRIL 1975
SCALE: 1" = 50'-0"
SPEC NO
DRAWING NUMBER: Q2-52/168.2

PLATE A-9

RECORD DRAWING AS CONSTRUCTED DATED 7 May 1981

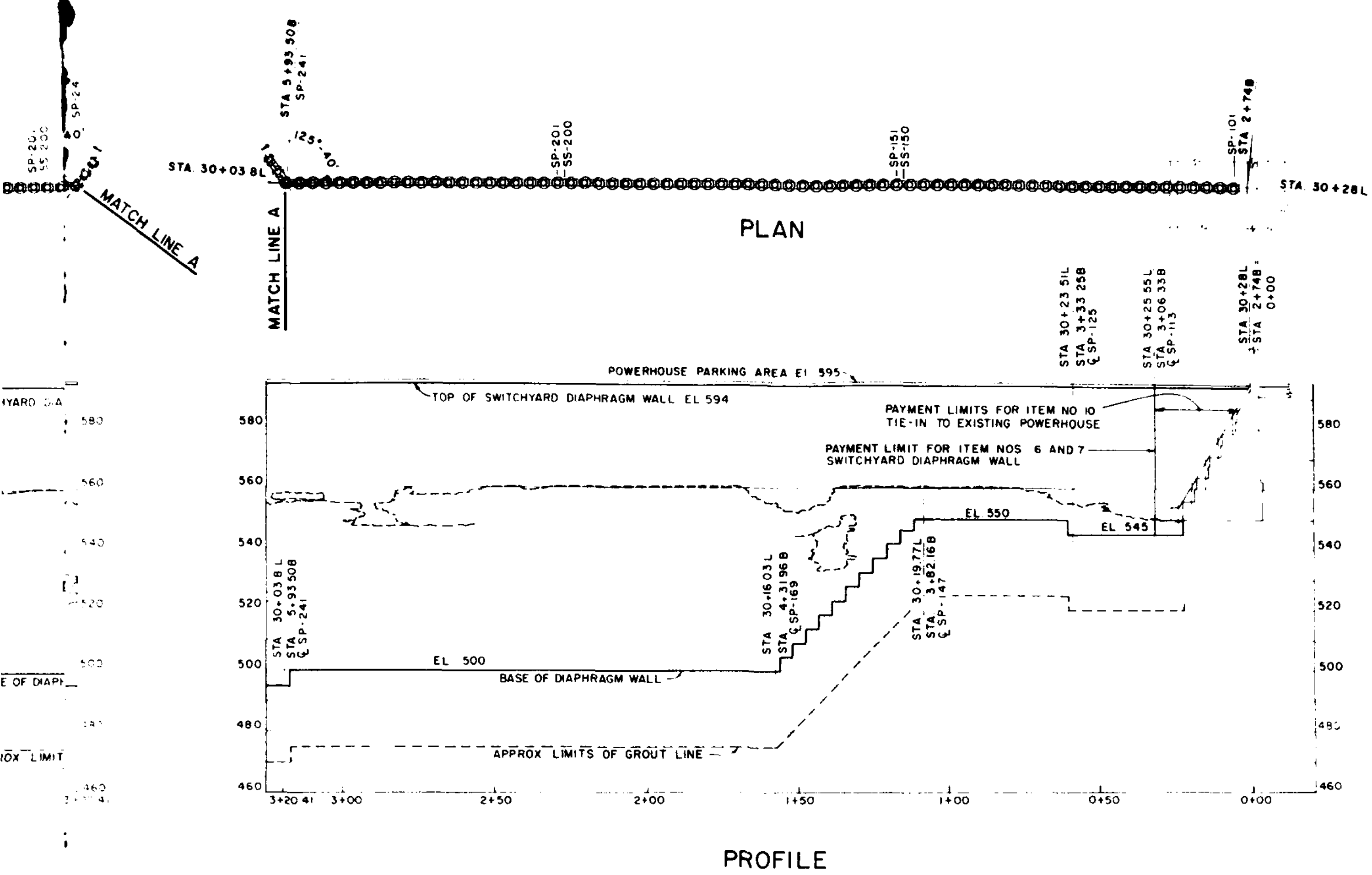


PLAN



PROFILE

NOTE
For ge
see D



NOTE
For geologic section along diaphragm wall alignment, see Dwgs 02-52/200 and 02-52/201

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-19-75	MINOR REVISION	KMW	

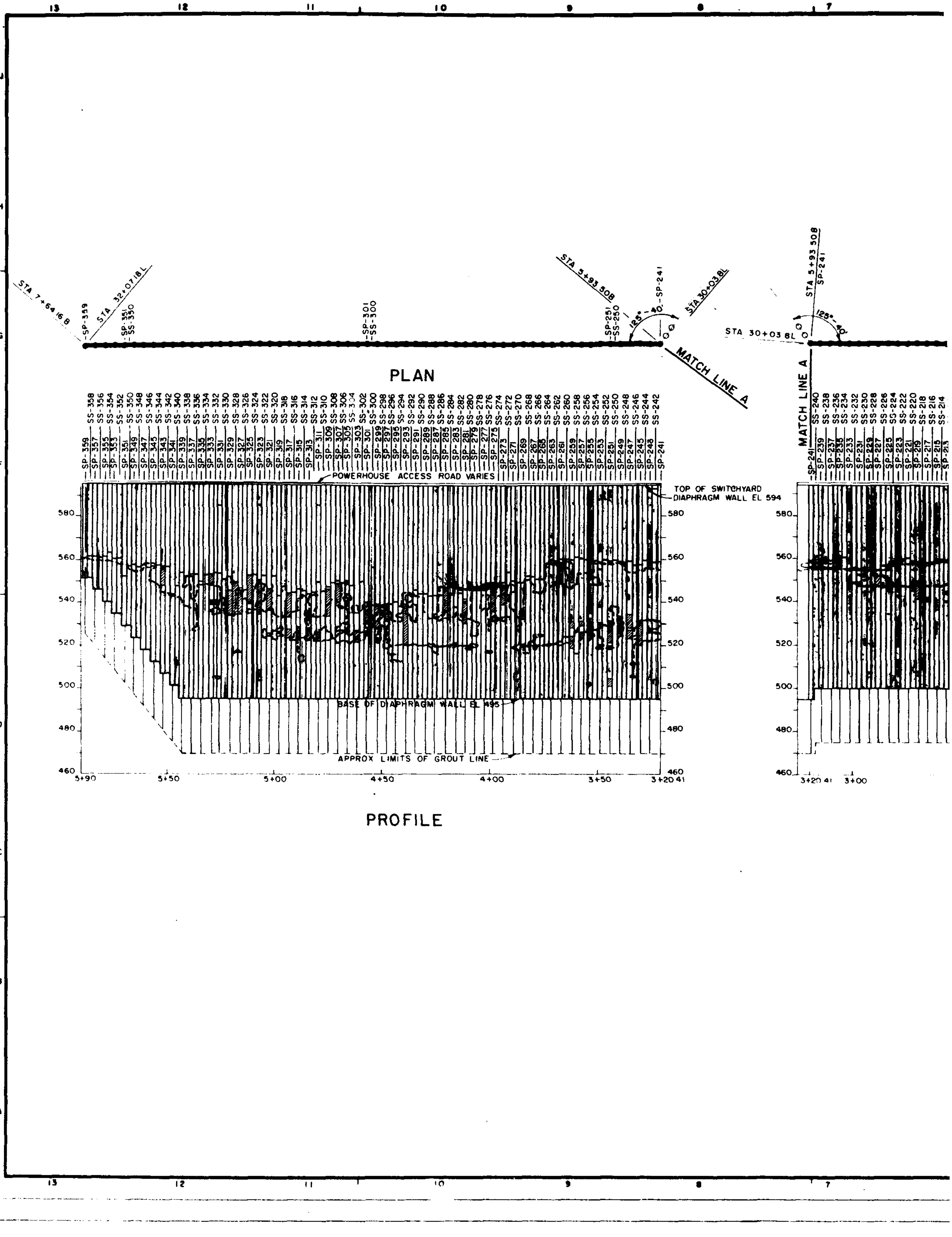
GRAPHIC SCALE: 20 0 20 40

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

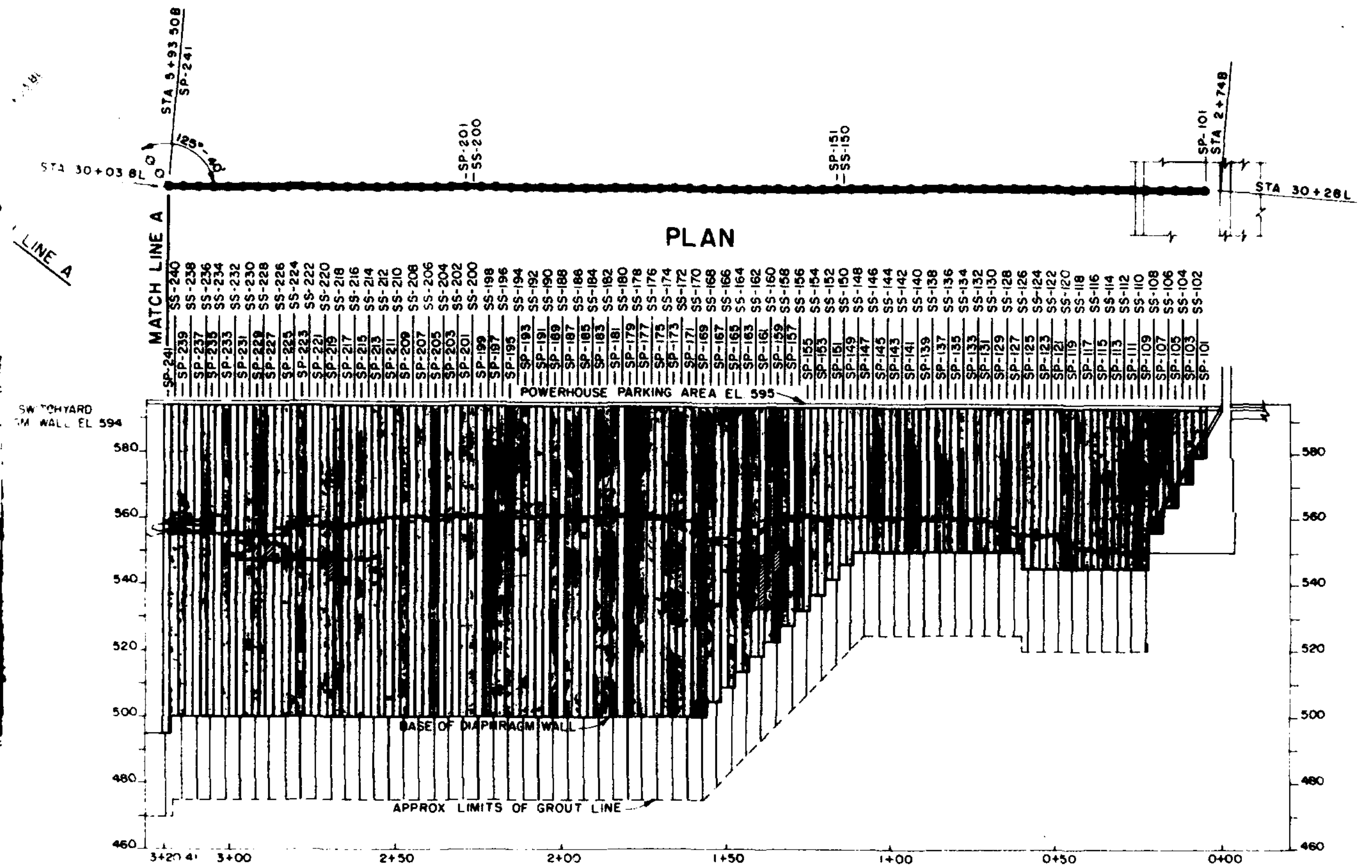
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
SWITCHYARD DIAPHRAGM WALL
(ICOS)
PLAN & PROFILE

DRAWN: Whitley
CHECKED: NLY
TRACED:
COMPARED:
DESIGNED: Albert J. ...
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS SECTION
APPROVAL RECOMMENDED:
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
SCALE: 1" = 20'
DATE: APRIL 1975
DRAWING NUMBER: 02-52/1691

RECORD DRAWING AS CONSTRUCTED DATED ... 2 May 79



PLAN
STA 7+64.16 B
STA 32+07.18 L
STA 5+93.50 B
STA 30+03.8 L
MATCH LINE A
POWERHOUSE ACCESS ROAD VARIES
TOP OF SWITCHYARD DIAPHRAGM WALL EL 594
BASE OF DIAPHRAGM WALL EL 495
APPROX LIMITS OF GROUT LINE
PROFILE



LEGEND

TOP OF ROCK

CAVITY ENCOUNTERED DURING EXCAVATION

COMPLETED ELEMENT

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

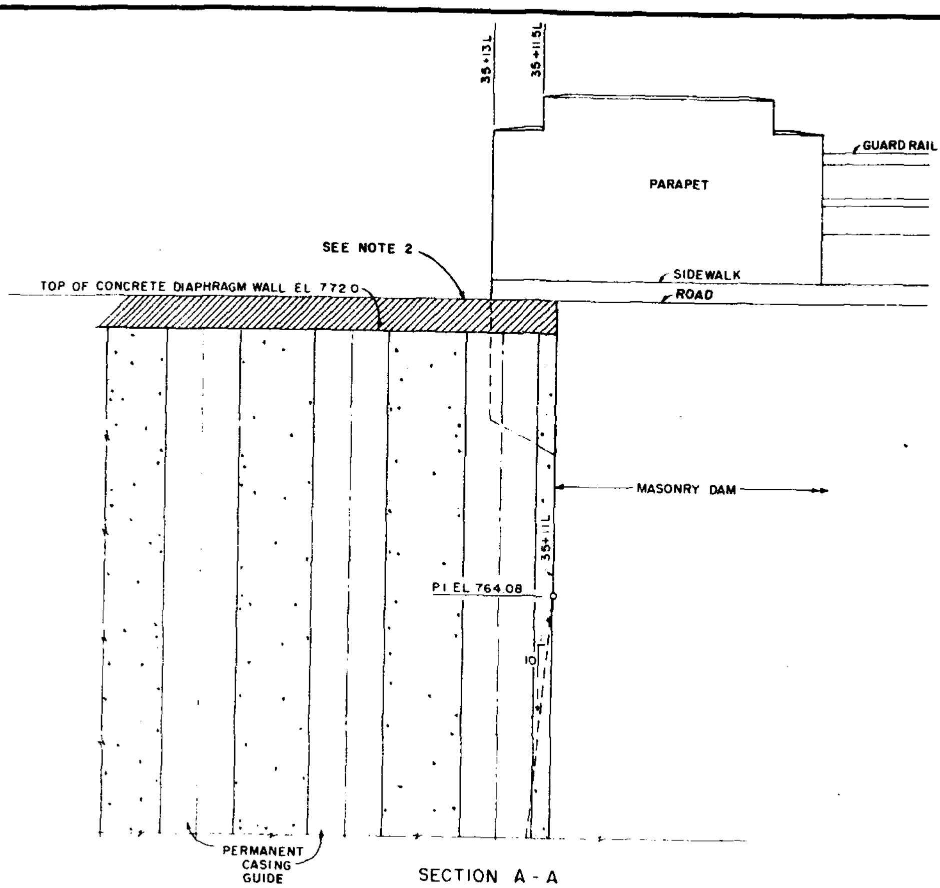
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

SWITCHYARD DIAPHRAGM WALL (ICOS)
SOLUTION FEATURES

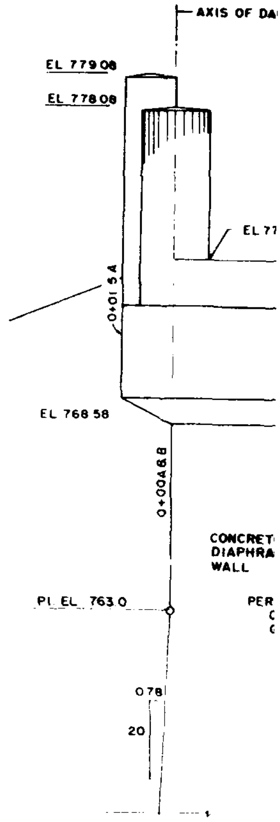
SCALE 1"=20'

02-52/169A

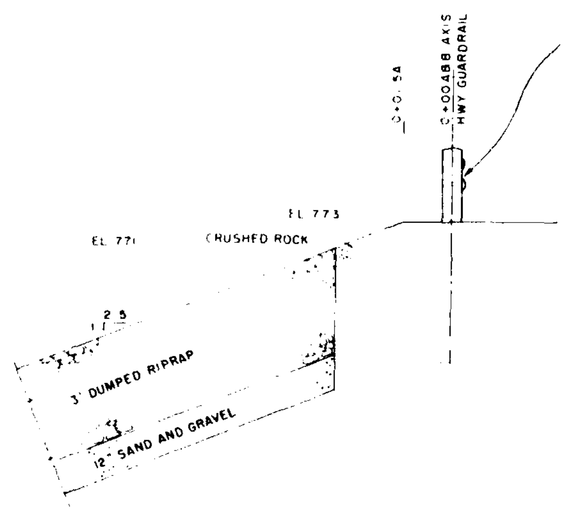
PLATE A-11[2]

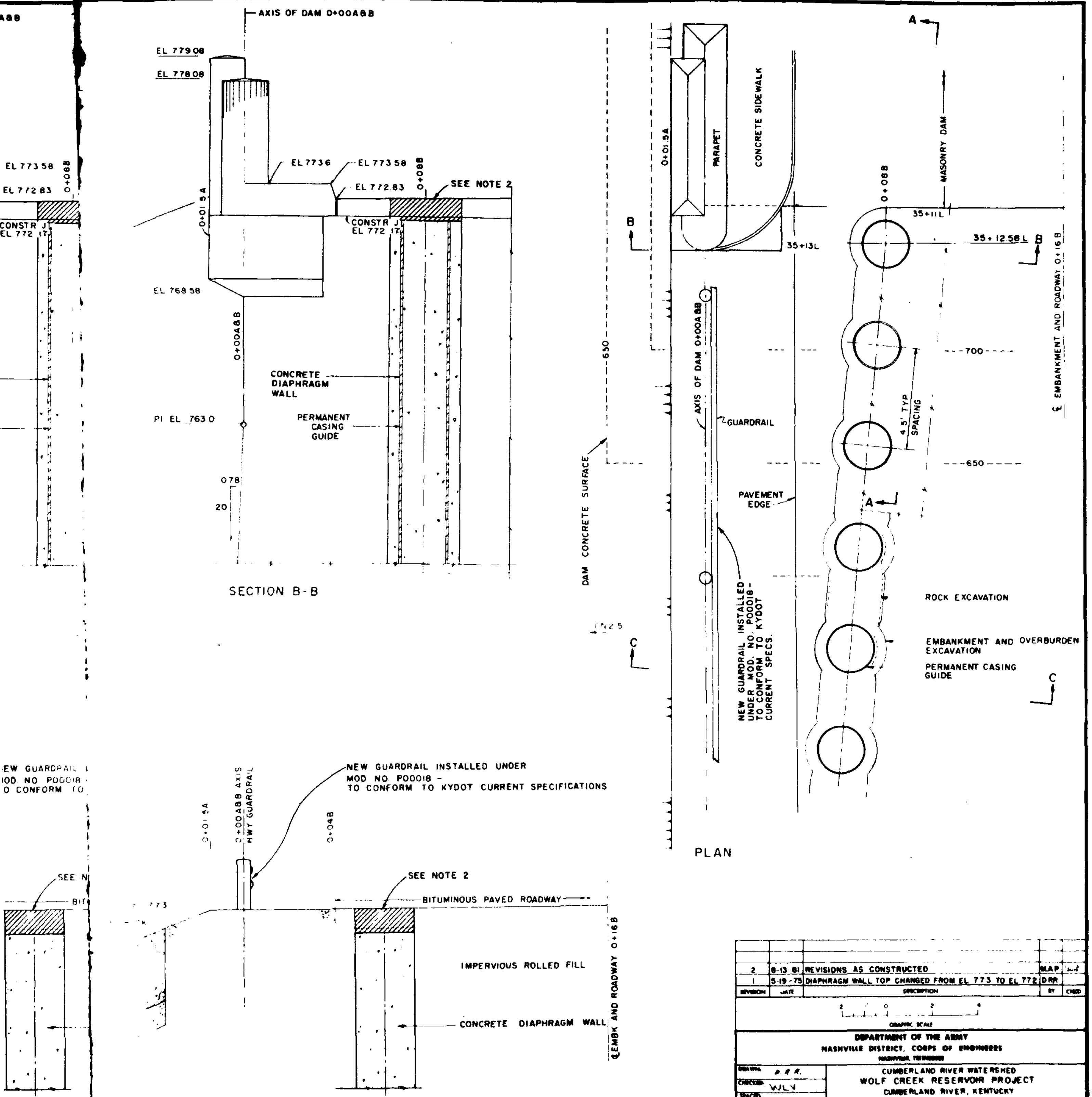


SECTION A - A



SECTION B - B





ECTION C-C

SECTION C-C

NOTE
1. THE PERMANENT CASING GUIDE SHALL BE A MINIMUM 24 INCH CASING OR OTHER APPROVED GUIDE
2. SEE SPECIFICATIONS FOR REPAIRS TO EXISTING ROADWAY DAMAGED OR REMOVED

REVISION	DATE	DESCRIPTION	BY	CHKD
2	8-13-81	REVISIONS AS CONSTRUCTED	MAP	
1	5-19-75	DIAPHRAGM WALL TOP CHANGED FROM EL 773 TO EL 772	DRR	

GRAPHIC SCALE

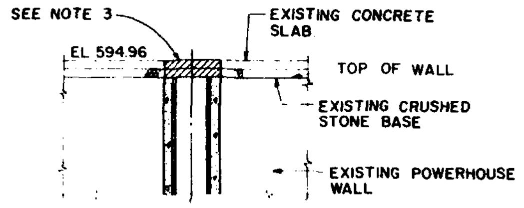
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
EMBANKMENT DIAPHRAGM WALL
(ICOS)
DETAILS

DRAWN: D.R.R.
CHECKED: WLV
DATE: APRIL 1975

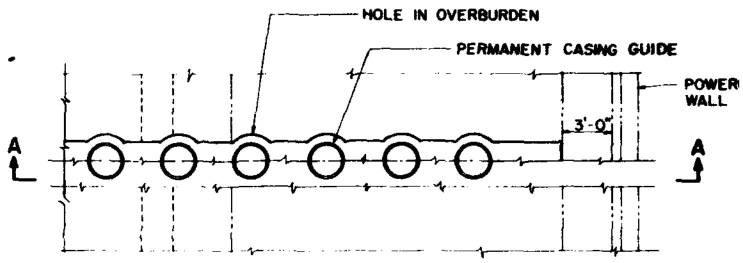
02-52/1705

PLATE A-12



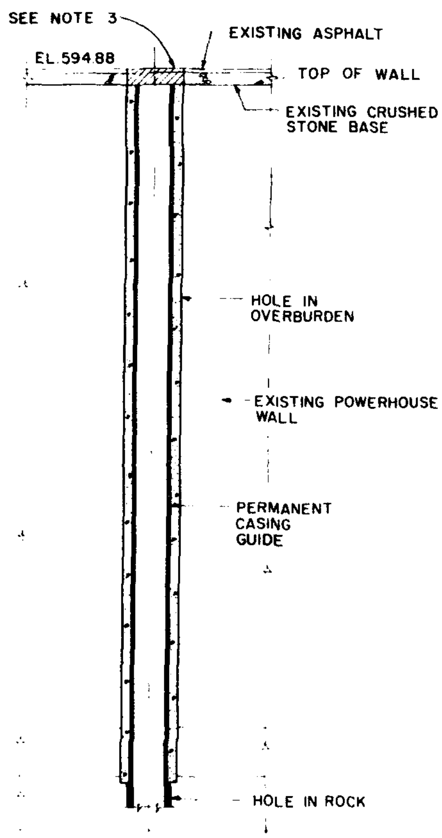
SECTION C-C

SCALE 1" = 4'



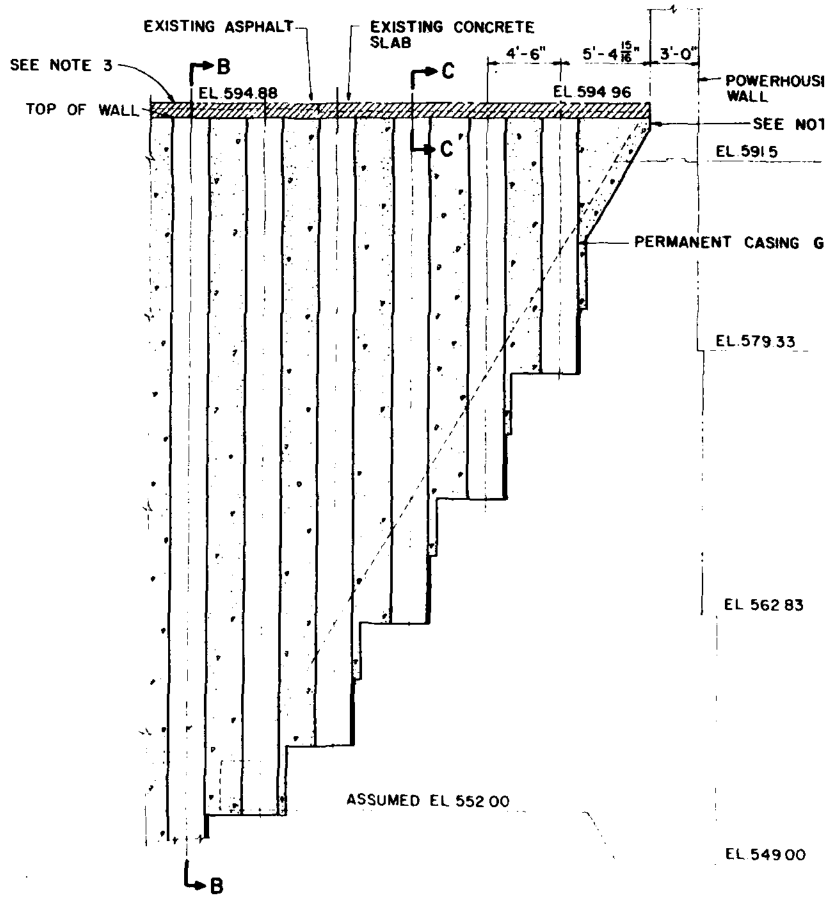
PLAN

SCALE 1"=4'



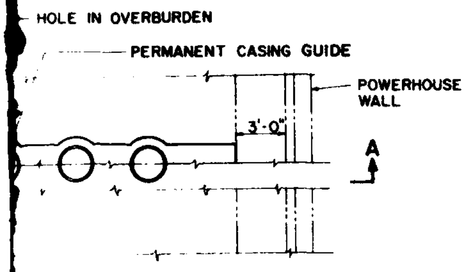
SECTION B-B

SCALE 1" = 4'



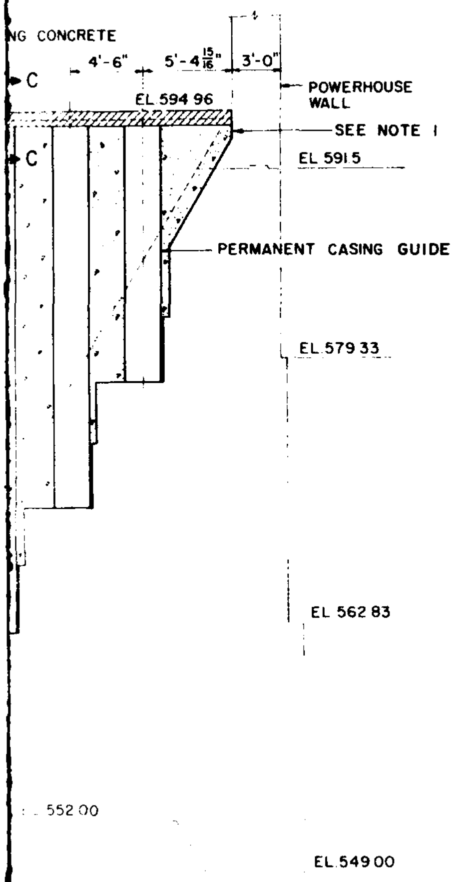
SECTION A-A

SCALE 1" = 4'



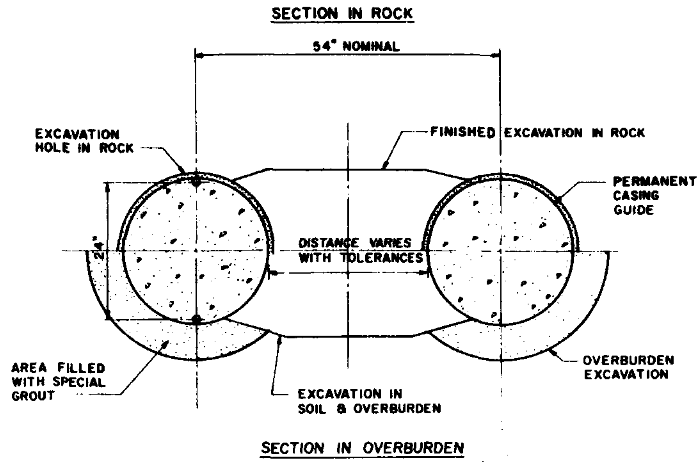
AN

E 1"=4'



ON A-A

4'



TYPICAL CONNECTION BETWEEN HOLES

N.T.S.

GENERAL NOTES:

1. THE LAST SEGMENT OF THE SWITCHYARD WALL TIEING INTO THE EXISTING POWERHOUSE MAY BE A FORMED WALL.
2. THE PERMANENT CASING GUIDE SHALL BE A MINIMUM 24 INCH CASING OR OTHER APPROVED GUIDE.
3. SEE SPECIFICATIONS FOR REPAIRS TO EXISTING ROADWAYS AND PARKING AREAS DAMAGED OR REMOVED

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-19-75	MINOR REVISIONS	KMW	

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

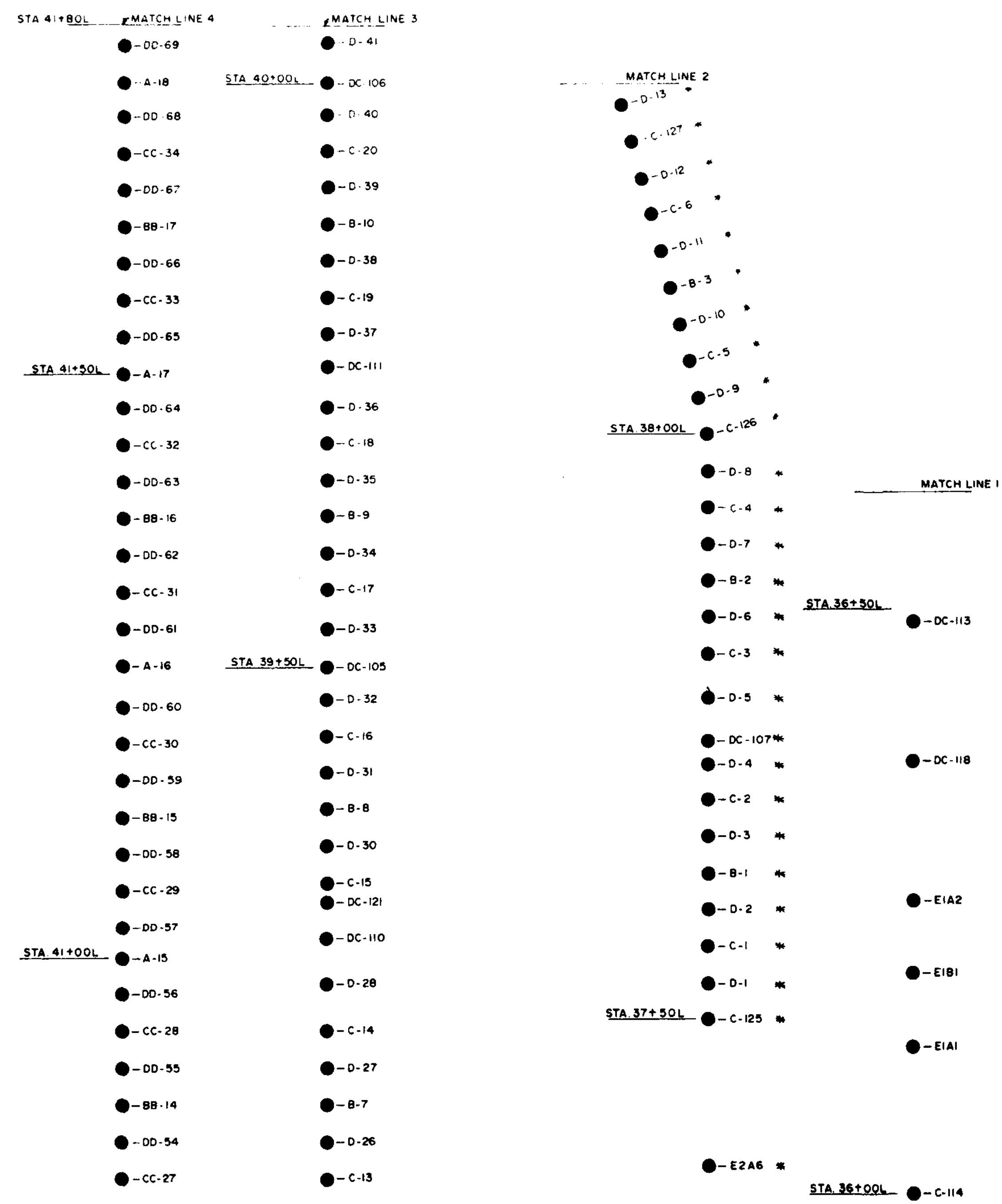
DRAWN Whitley

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
SWITCHYARD DIAPHRAGM WALL (ICOS)
DETAILS

COLONEL, C.E. DISTRICT ENGINEER

DATE APRIL 1975

02-52/171.1

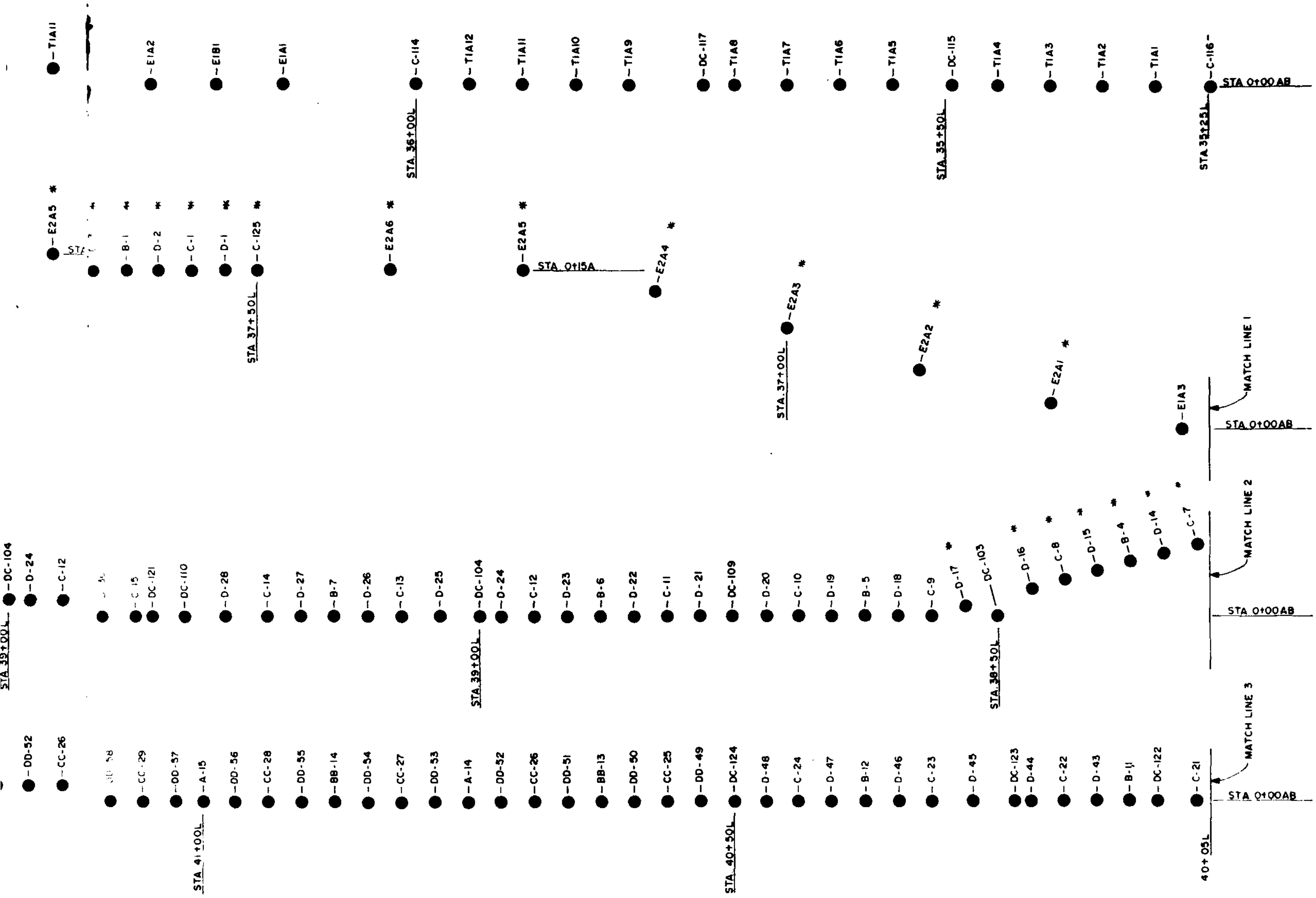


NOTES

1. Ho

2. Ho

3 Fo



rked with as
truction tail
ent in this a
re drilled a
126 and DC
rom top of gr
require rem
-110 has 93'
e embankmen
nately 90' b
ic sections a
nt see Dwg

NOTES

1. *Holes marked with asterisk were offset to avoid the construction tailtower buried in the embankment in this area. All remaining holes were drilled along Sta. 0+00 AB.*
2. *Holes C-126 and DC-122 have grouted in casing from top of ground to top of rock that will require removal prior to excavation. Hole DC-110 has 93' feet of casing broken off in the embankment and grouted in approximately 90' below the surface.*
3. *For geologic sections along the wall alignment see Dwg. Nos. Q2-52/190, 191, and 192*

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

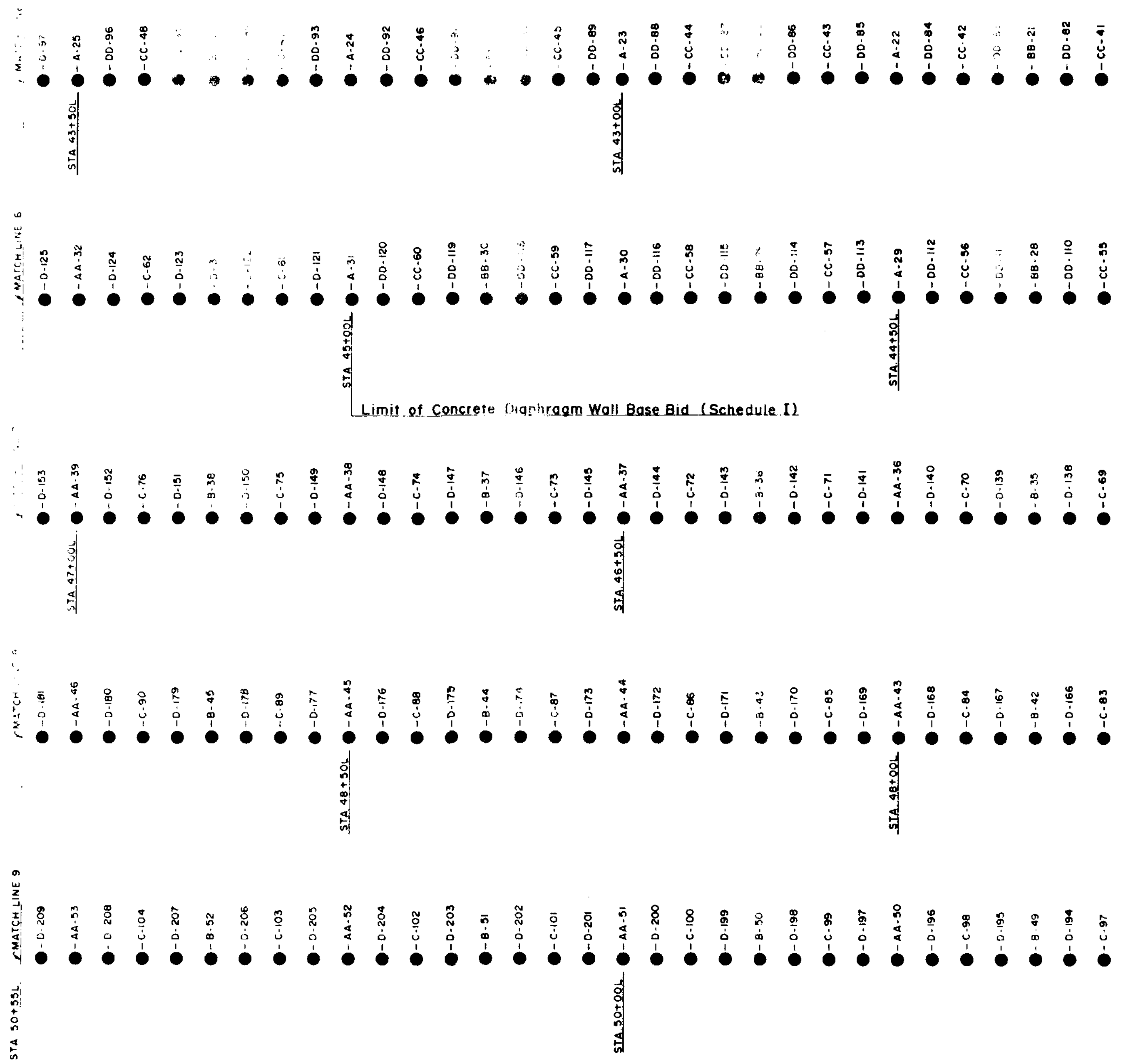
DRAWN
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVED
COLONEL, C.E. DISTRICT ENGINEER

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION
STA. 35+25L to 41+80L
HOLE LOCATIONS

APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
SCALE 1" = 5' SPEC. NO.
DRAWING NUMBER

DATE: APRIL, 1978
SHEET OF
Q2-52/186

PLATE A-14

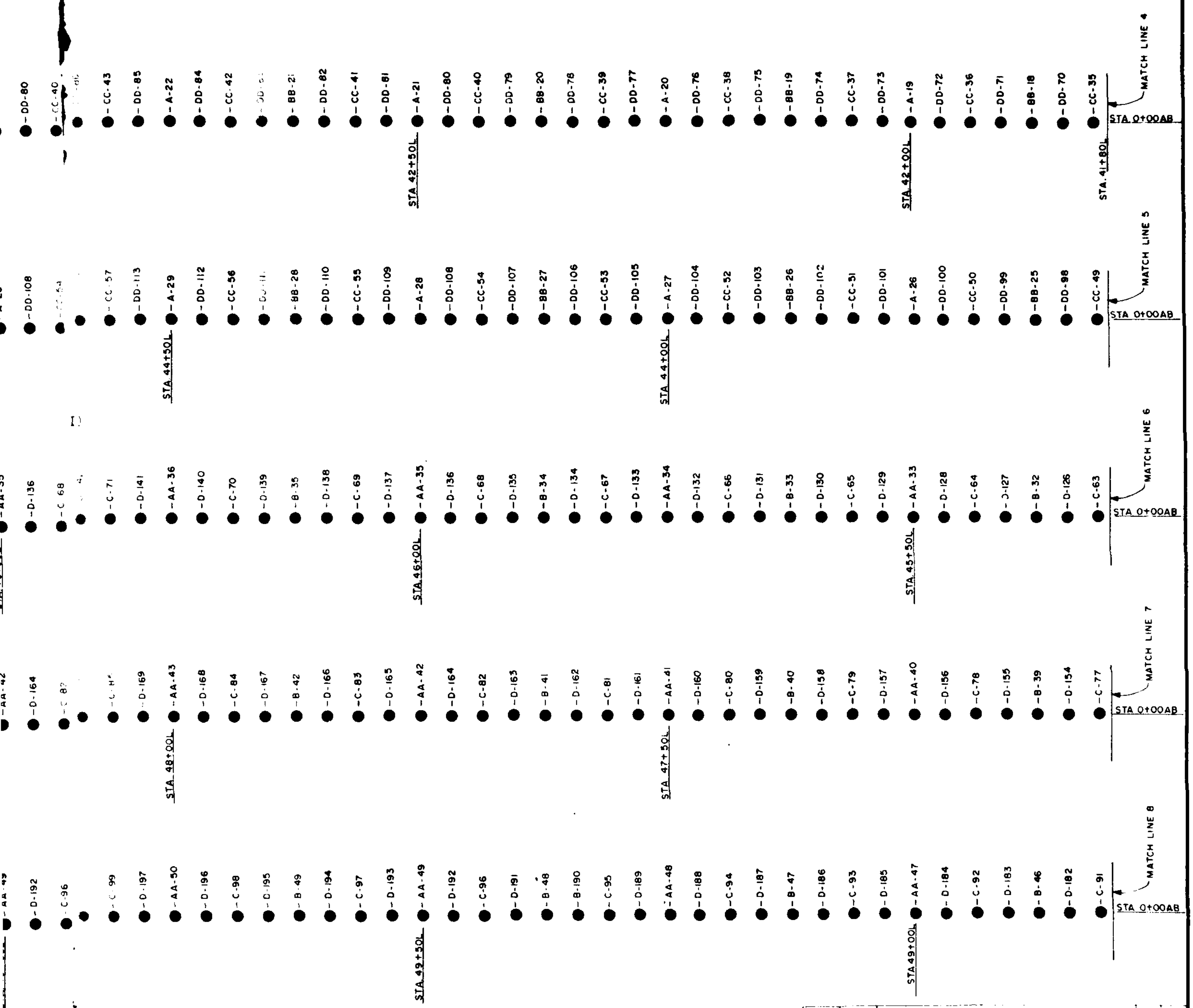


NOTES

1 All ho

2 For ge

see D



wn were dr
sections al
os Q2-52/

NOTES

1 All holes shown were drilled along Sta. 0+00AB.

2 For geologic sections along the wall alignment see Dwg. Nos. Q2-52/192 thru Q2-52/196

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-28-77	MINOR REVISIONS, TWO HOLE NOS CHANGED		

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

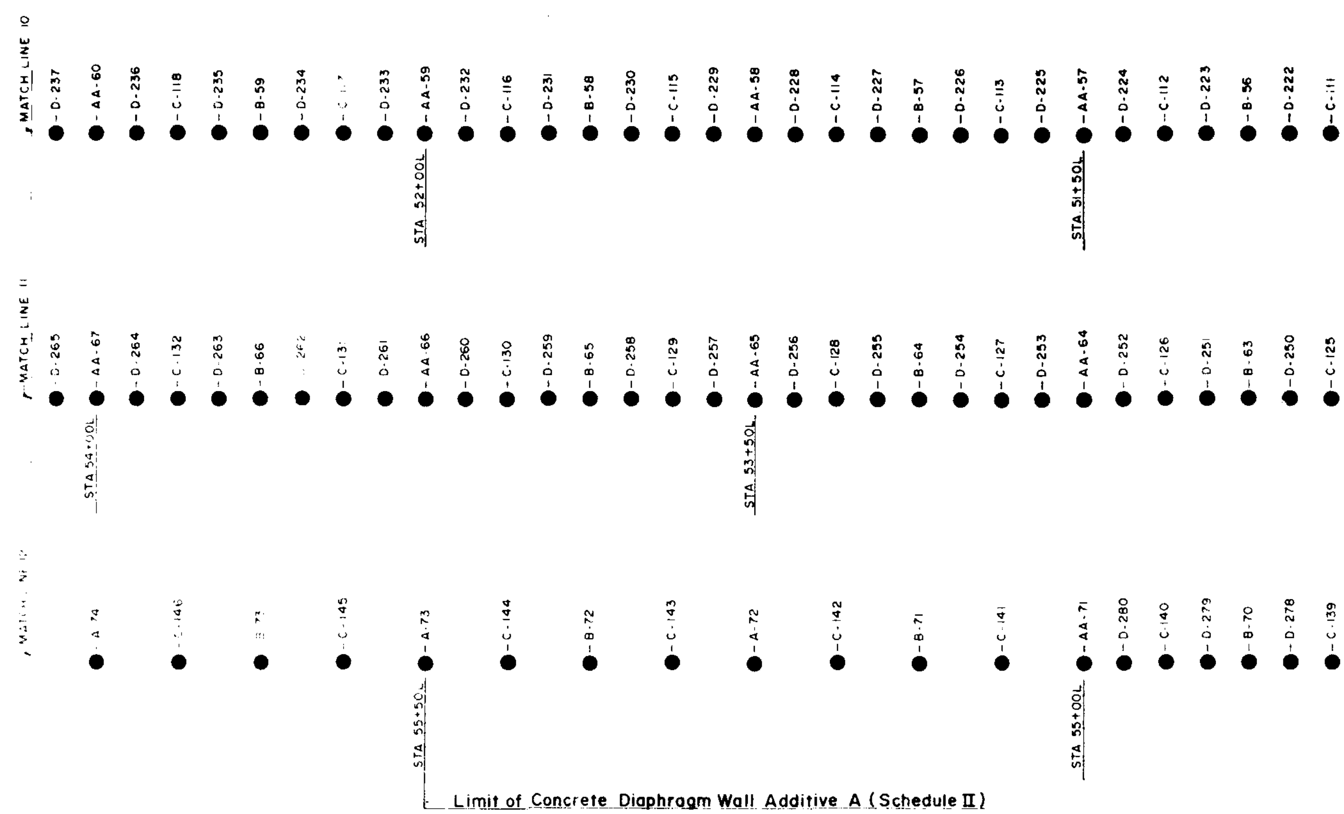
DRAWN: GSH
CHECKED:
TRACED:
COMPARED:
GEOLOGIST

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION
STA 41+80L to 50+65L
HOLE LOCATIONS

SUBMITTED:
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED:
CHIEF, ENGINEERING DIVISION
APPROVED:
COLONEL, C E DISTRICT ENGINEER
DATE: APRIL, 1975
SCALE: 1" = 5'
SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/187.1

PLATE A-15

7 May 1981

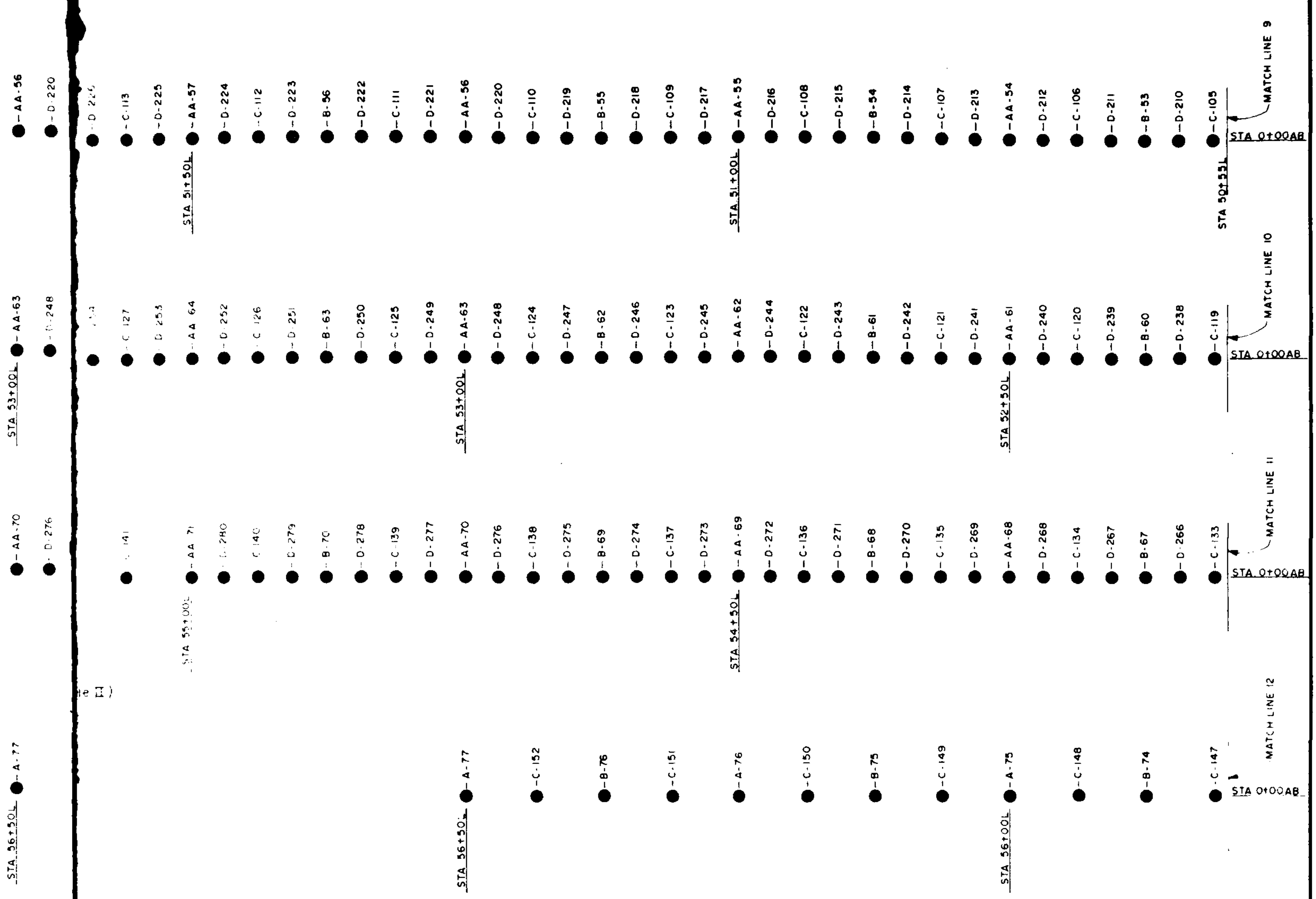


NOTES

1 All

2 For

Dw



NOTES

1. *All holes shown were drilled along Sta 0+00AB*
2. *For geologic sections along wall alignment see Dwg. Nos Q2-52/196, 197, and 198*

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION
STA 50+55L to 56+60L
HOLE LOCATIONS

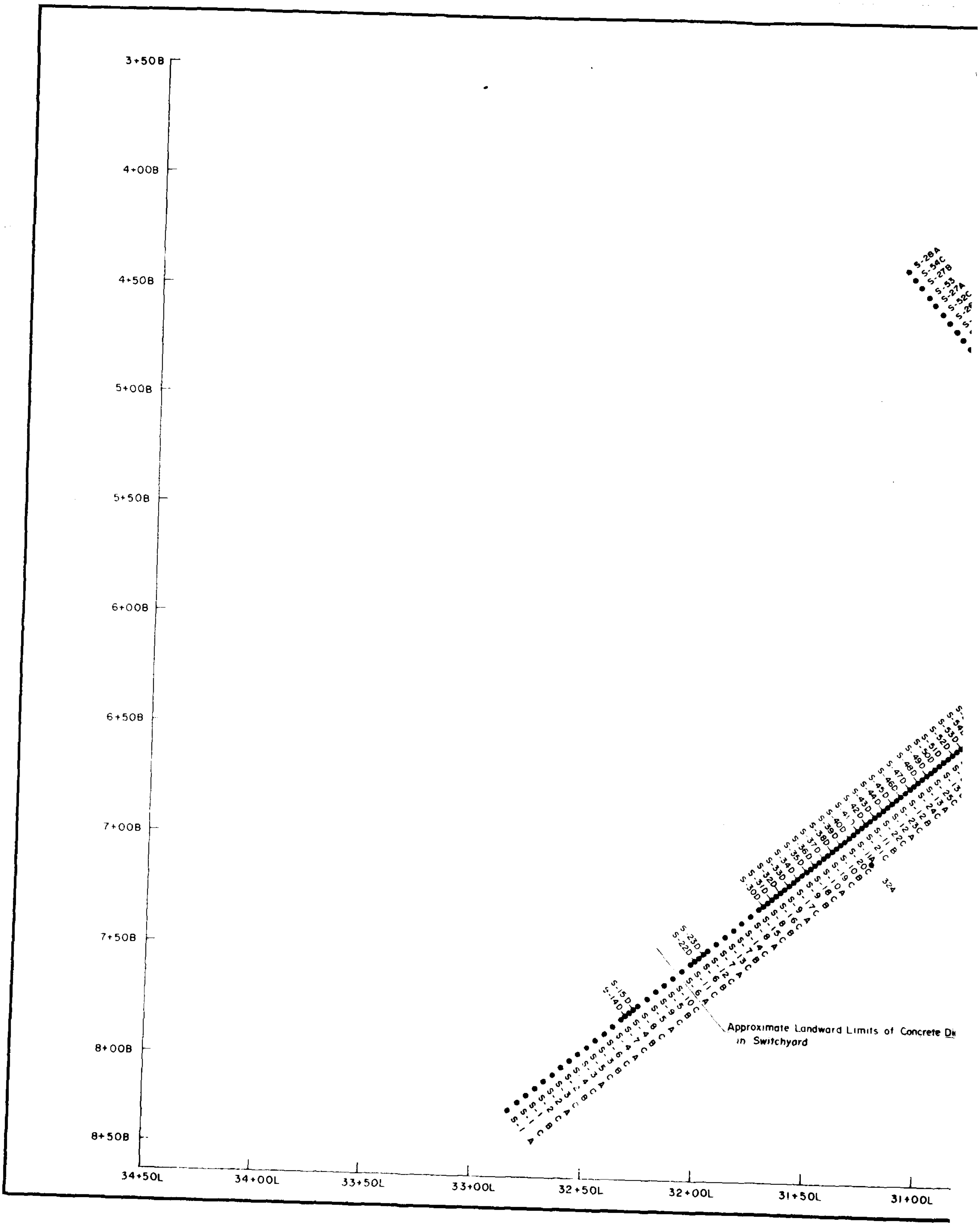
GEOLOGIST

CHIEF, FOUNDATIONS AND MATERIALS BRANCH

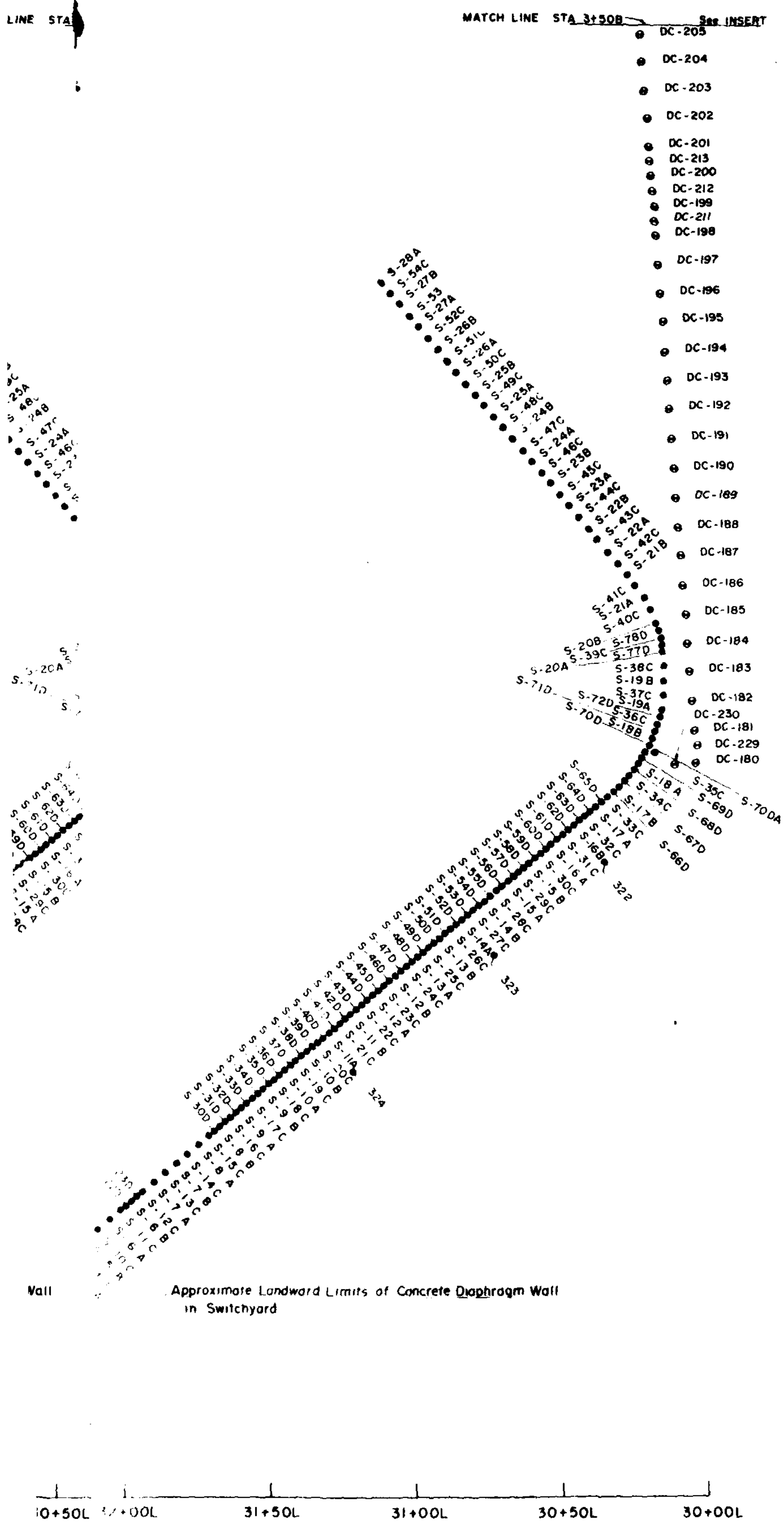
DATE APRIL, 1975

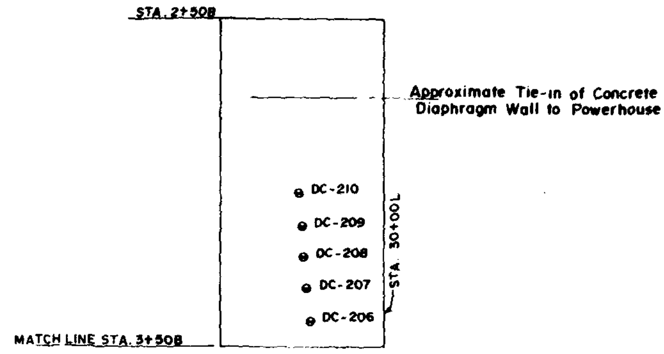
Q2-52/188

PLATE A-16



3+50B
4+00B
4+50B
5+00B
5+50B
6+00B
6+50B
7+00B
7+50B
8+00B
8+50B
34+50L
34+00L
33+50L
33+00L
32+50L
32+00L
31+50L
31+00L
Approximate Landward Limits of Concrete Di
in Switchyard





INSERT

LEGEND:

- ● *Contract exploratory hole*
- ⊖ *Government exploratory hole*

NOTES:

1. *For Geologic Section along Contract exploratory line see Dwg. No. Q2-52/201*
2. *For Geologic Section along Government exploratory line see Dwg. No. Q2-52/200*

REVISION	DATE	DESCRIPTION	BY	CHKD

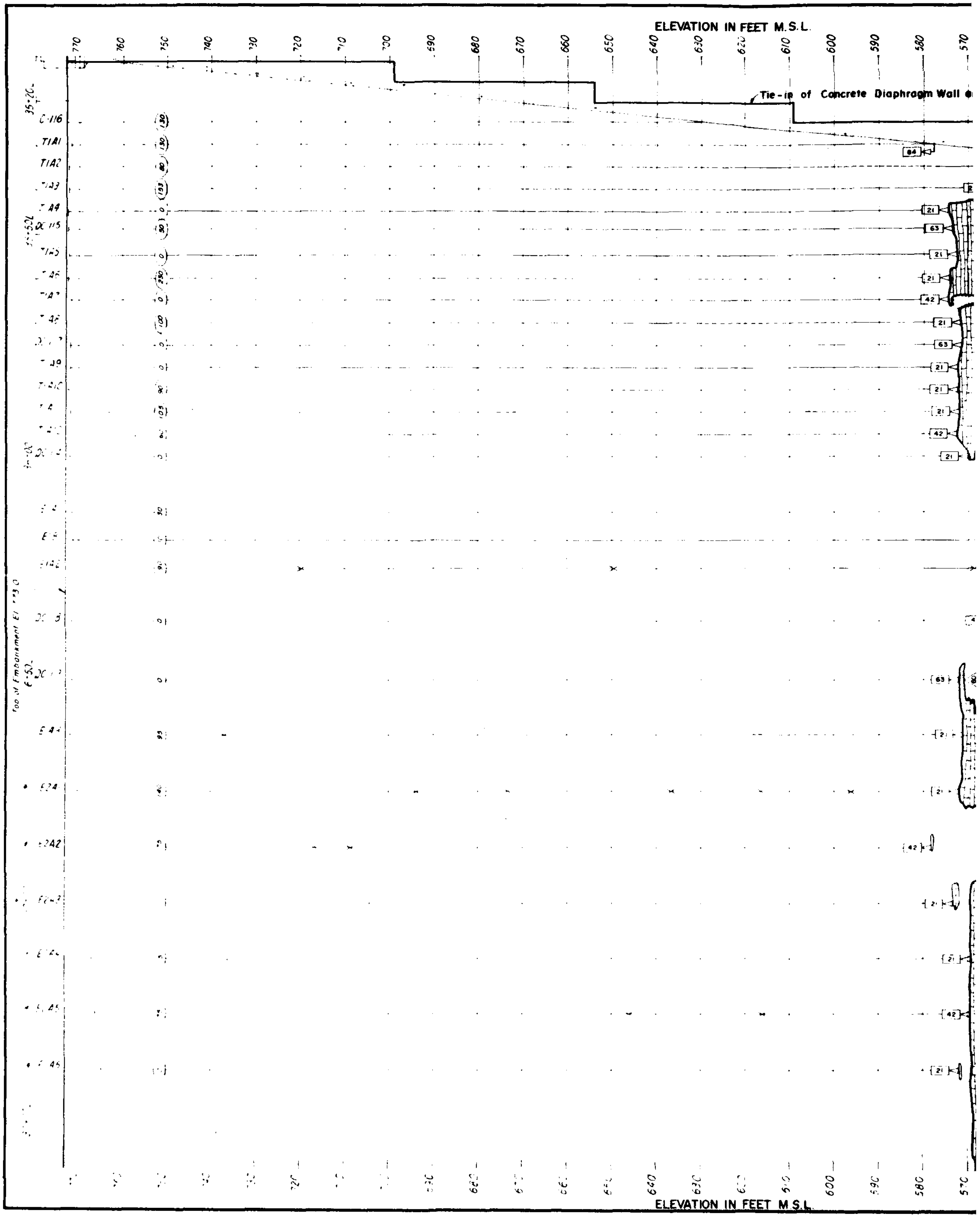
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

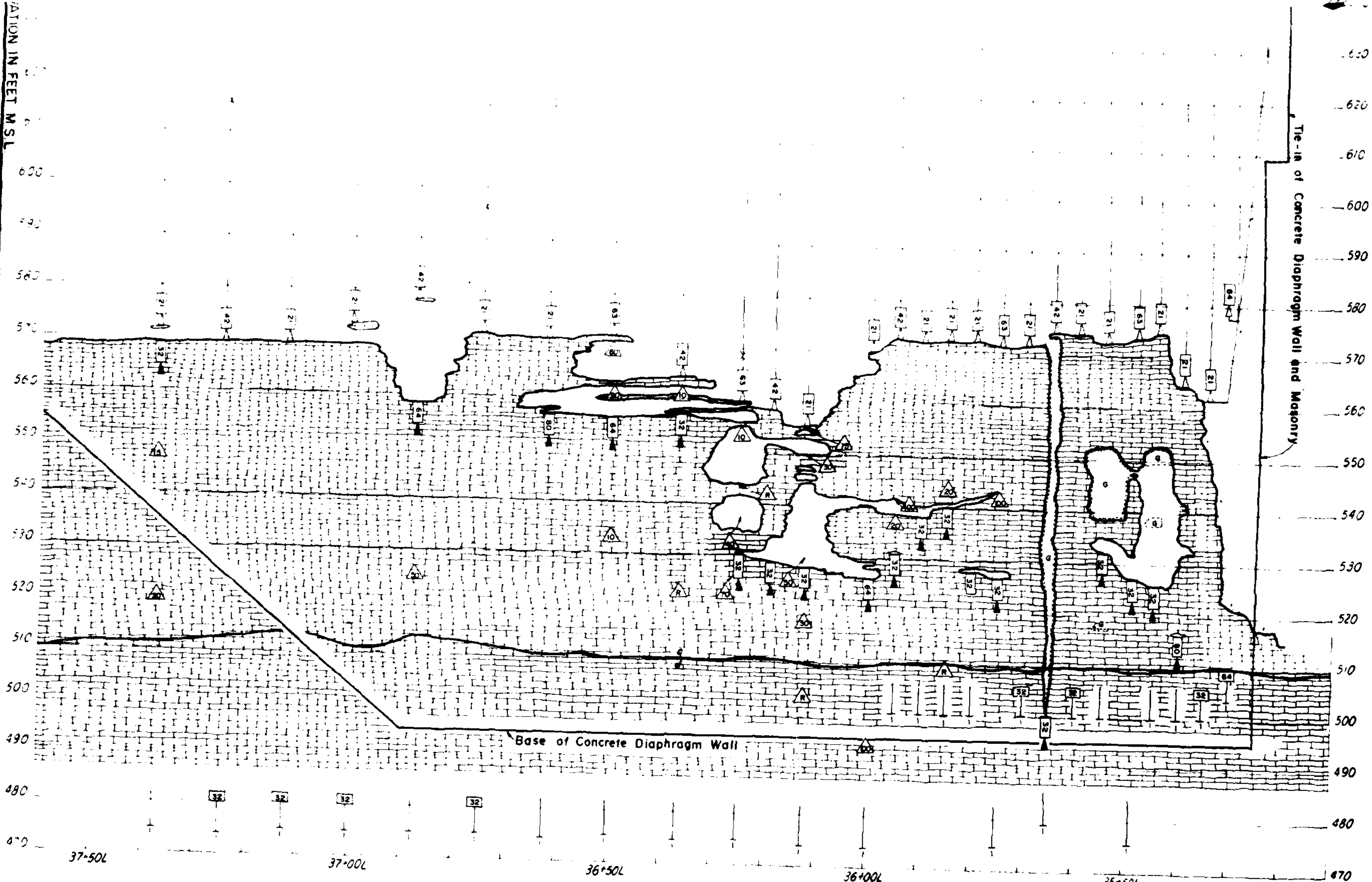
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION — SWITCHYARD
HOLE LOCATIONS

DRAWN: GW & G.J.
CHECKED:
TRACED:
COMPARED:
GEOLOGIST
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
SCALE 1"=20'
SPEC NO
DRAWING NUMBER
DATE APRIL, 1979
SHEET OF
Q2-52/189

PLATE A-17



ELEVATION IN FEET M.S.L.
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
Tie-in of Concrete Diaphragm Wall
C-116
T1A1
T1A2
T1A4
ELEVATION IN FEET M.S.L.



LEGEND

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise indicated
- Grout encountered during drilling
- c/d Leipers-Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- R 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. All holes are drilled along STA 0+00AB except those noted by an asterisk. For approximate hole and section locations See Dwg No Q2-52/186
2. Hole C-116 and T1A1 encountered the sloping face of monolith 37 and traveled down the surface before entering the concrete and are not considered vertical
3. All elevations refer to Mean Sea Level Sandy Hook Datum.

REVISION	DATE	DESCRIPTION	BY	CHKD

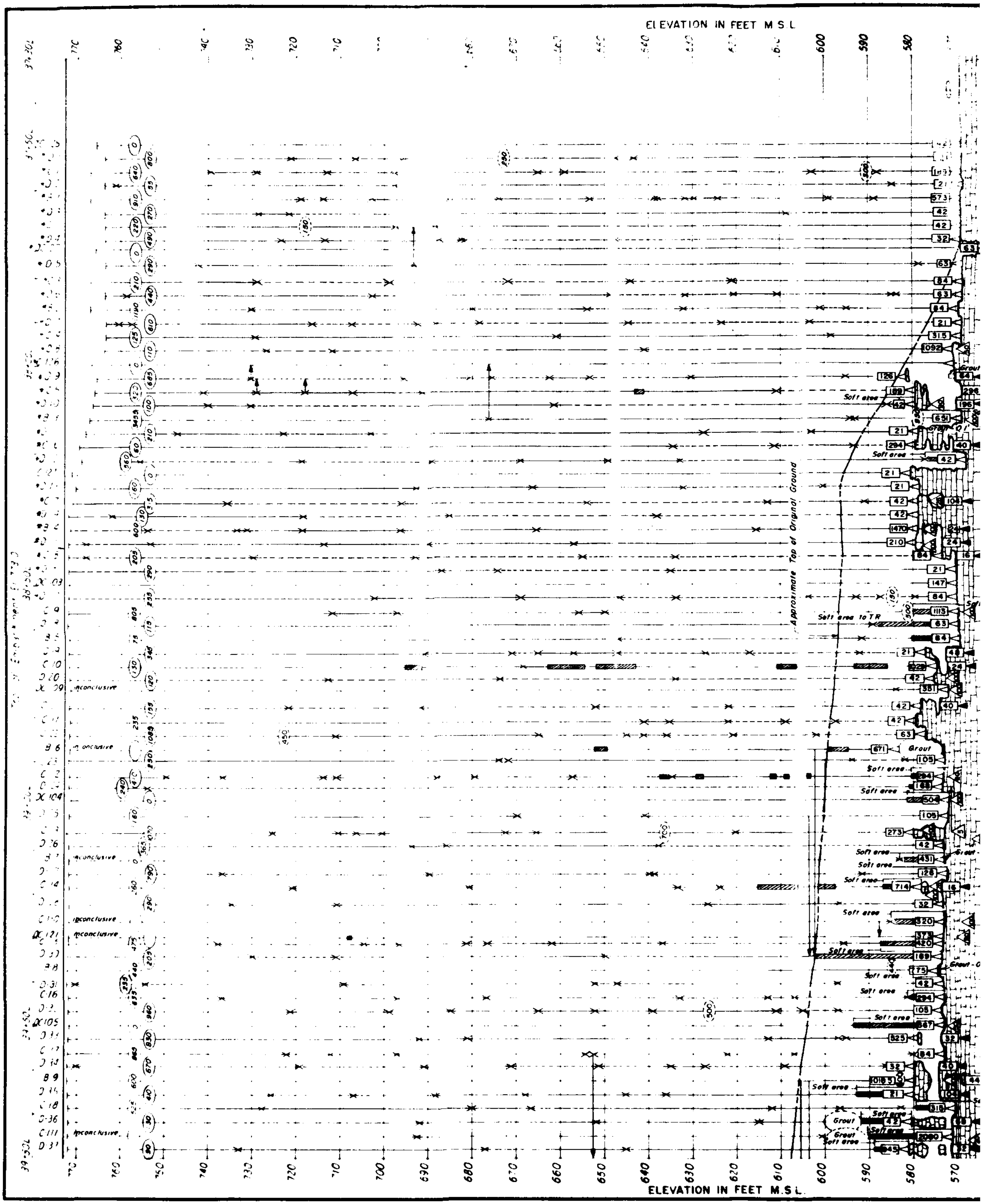
GRAPHIC SCALE

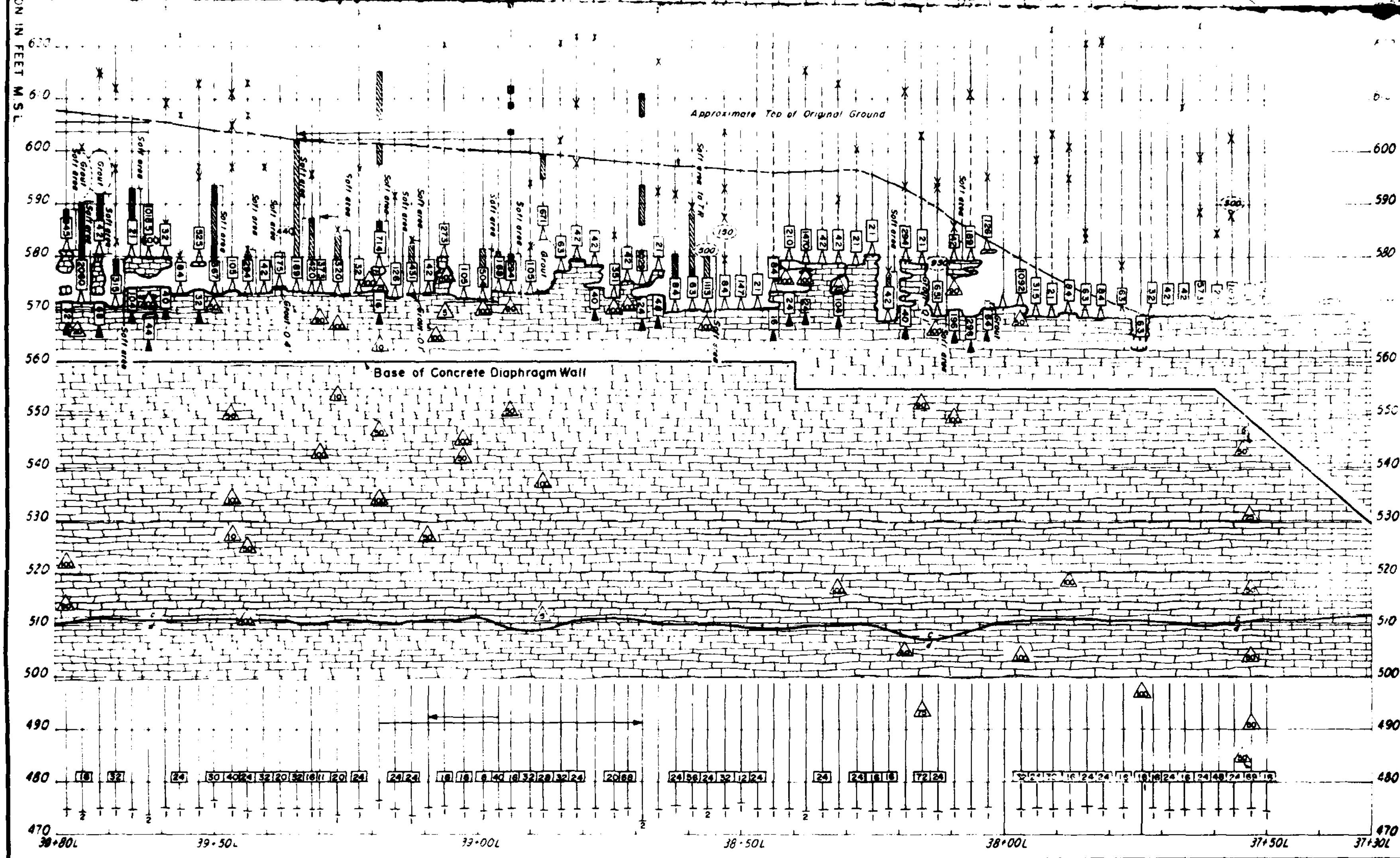
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

FOUNDATION EXPLORATION
STA. 35+20L to 37+60L
GEOLOGIC SECTION

DRAWN
CHECKED
TRACED
COMPARED
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL C E DISTRICT ENGINEER
SCALE 1" = 10'
SPEC NO
DRAWING NUMBER
DATE APRIL, 1975
SHEET of
Q2-52/190


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
Soft area
Grout
inconclusive
ELEVATION IN FEET M.S.L.



LEGEND

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact — All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES:

1. All holes indicated on section are drilled along Sta. 0+00 AB except those noted by an asterisk. For approximate locations of all holes see Dwg. No. Q2-52/186.
2. Hole C-126 has not been backfilled and is cased to top of rock, casing is grouted in.
3. Approximately 92' of NX casing was broken off in hole C-110 and was not recovered. Casing is grouted in place.
4. The rock portion of hole D-26 was backfilled during backfilling of hole D-24.
5. All elevations refer to Mean Sea Level Sandy Hook Datum.

REVISION	DATE	DESCRIPTION	BY	CHKD

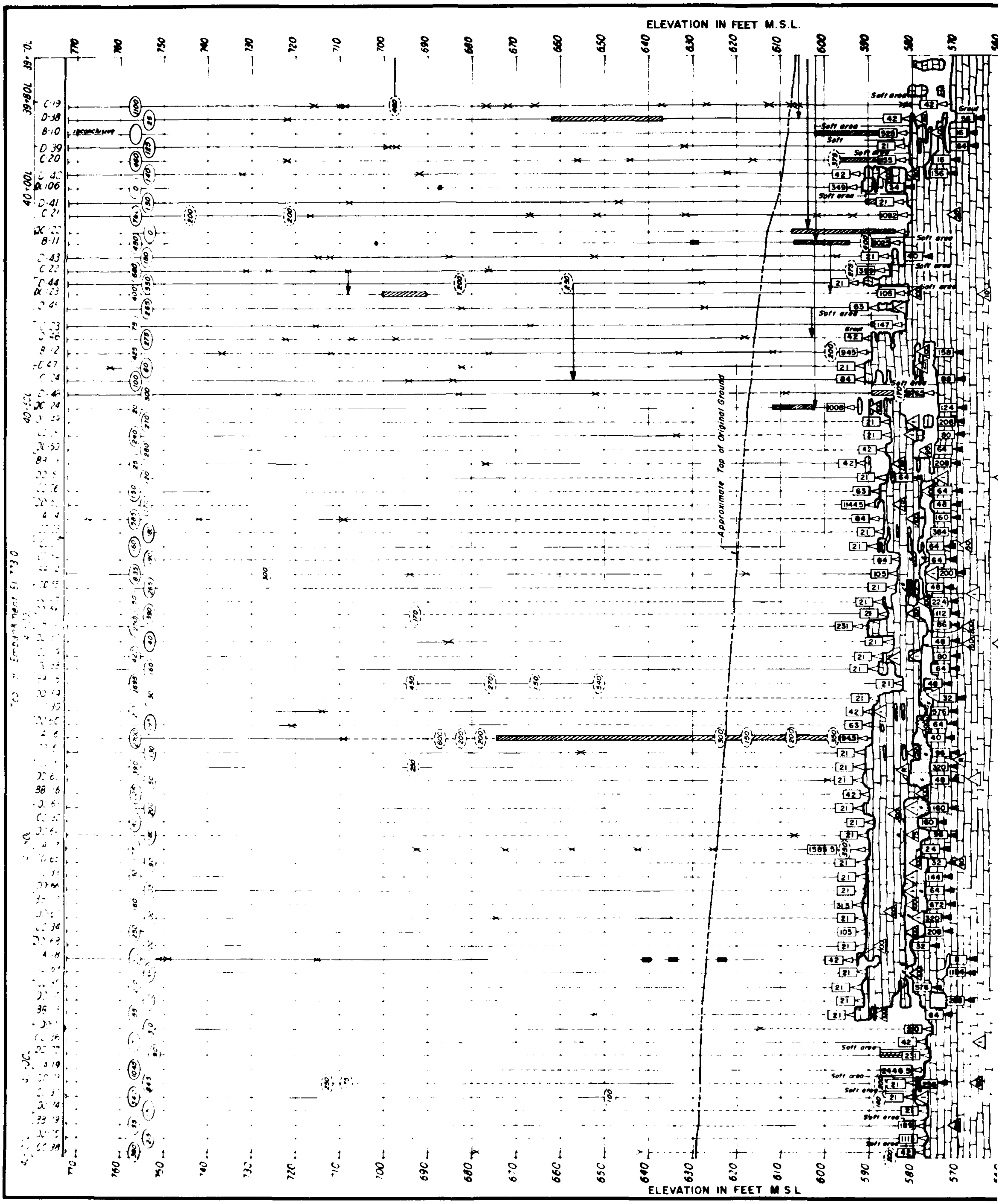
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

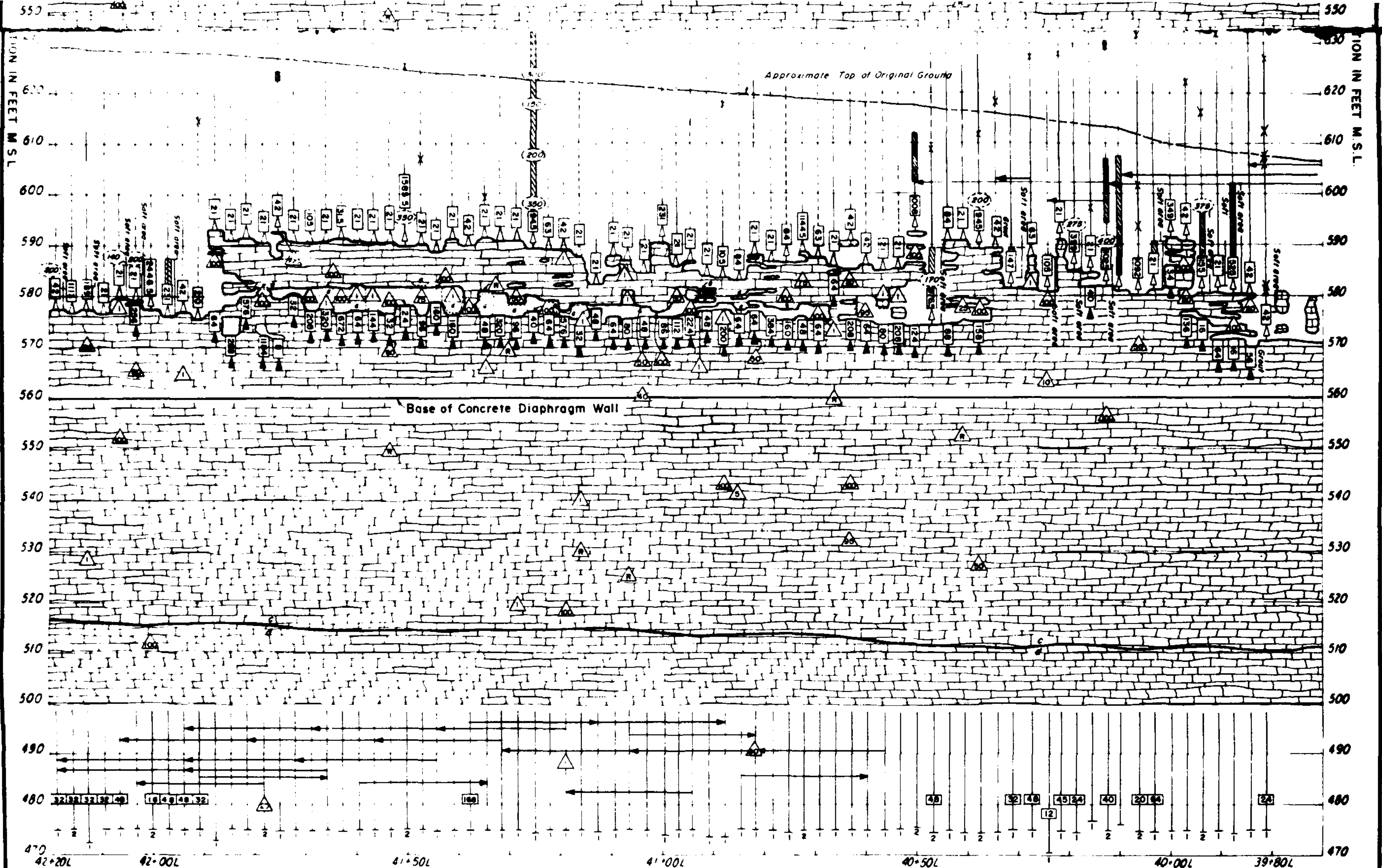
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE I
STA. 37+30L to STA. 39+80L
GEOLOGIC SECTION

DRAWN: [signature]
CHECKED:
TRACED:
COMPARED:
[signature] GEOLOGIST
SUBMITTED: [signature] CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED:
CHIEF, ENGINEERING DIVISION
APPROVED:
COLONEL, C.E. DISTRICT ENGINEER
SCALE: 1" = 10'
SPEC. NO.
DRAWING NUMBER
DATE: APRIL, 1975
SHEET OF
Q2-52/191

[signature] 7 May 1981

PLATE A-19 Q2-52/191


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
Soft area
Grout
inconclusive
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100 % drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. For approximate locations of all holes see DWG Nos 02-52/186 and 187
2. Phase II 3 $\frac{1}{3}$ c.c. exploratory holes begin at Sta 40+50L and extend to Sta 45+00L and are designated BB, CC, and DD. Phase I 25' c.c holes extend to Sta 45+00L and are designated A
3. Hole DC-122 was not backfilled and is cased to top of rock. Casing is grouted in place
4. The rock portion of hole D-46 was backfilled during backfilling of hole D-45
5. All elevations refer to Mean Sea Level Sandy Hook Datum.

REVISION	DATE	DESCRIPTION	BY	CHKD.

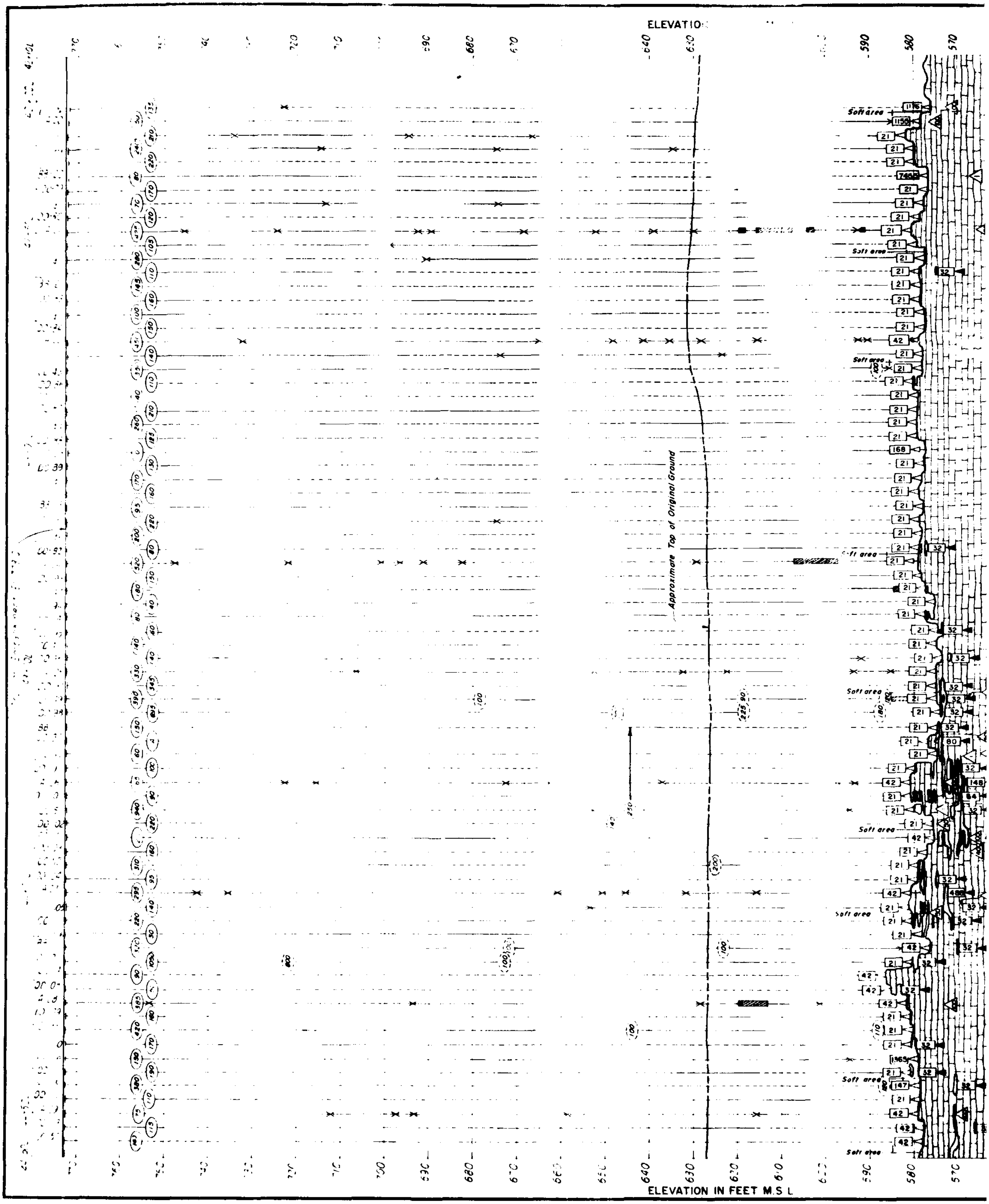
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE I AND II
STA 39+70L to STA 42+20L
GEOLOGIC SECTION

DRAWN: CHECKED: TRACED: COMPARED:
GEOLOGIST
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C E DISTRICT ENGINEER
DATE: APRIL, 1975
SCALE: 1" = 10' SPEC. NO. DRAWING NUMBER
SHEET OF Q2-52/192

Duane A. Dyer 7 May 1981


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
Soft area
640
630
620
610
590
580
570
680
670

LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- (450) Gallons of mud lost per hole
- (600) Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- (G) Grout encountered during drilling
- c/d Leipers - Catheys contact - All members are crystalline, variably shaly limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG. NO Q2-52/187
2. PHASE II [illegible] EXPLORATORY HOLES BEGIN AT STATION 40+50L, EXTEND TO STATION 45+00L AND ARE DESIGNATED BB, CC, AND DD. PHASE [illegible] 25 [illegible] HOLES EXTEND TO STATION 45+00L AND ARE DESIGNATED A.
3. EMBANKMENT PORTION OF DD 99 WAS DRILLED WITH AN AIR CIRCULATING DRILL.
4. [illegible] OF THE EMBANKMENT PORTION OF BB 24 AND [illegible] OF THE EMBANKMENT PORTION OF BB 26 WERE DRILLED WITH AN AIR CIRCULATING DRILL. BOTH HOLES WERE HALTED AND BACKFILLED BECAUSE OF LARGE DEVIATIONS FROM VERTICAL. AFTER BACKFILLING THE EMBANKMENT PORTION WAS DRILLED WITH A MUD CIRCULATING DRILL.
5. ALL ELEVATIONS REFER TO MEAN SEA LEVEL, SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

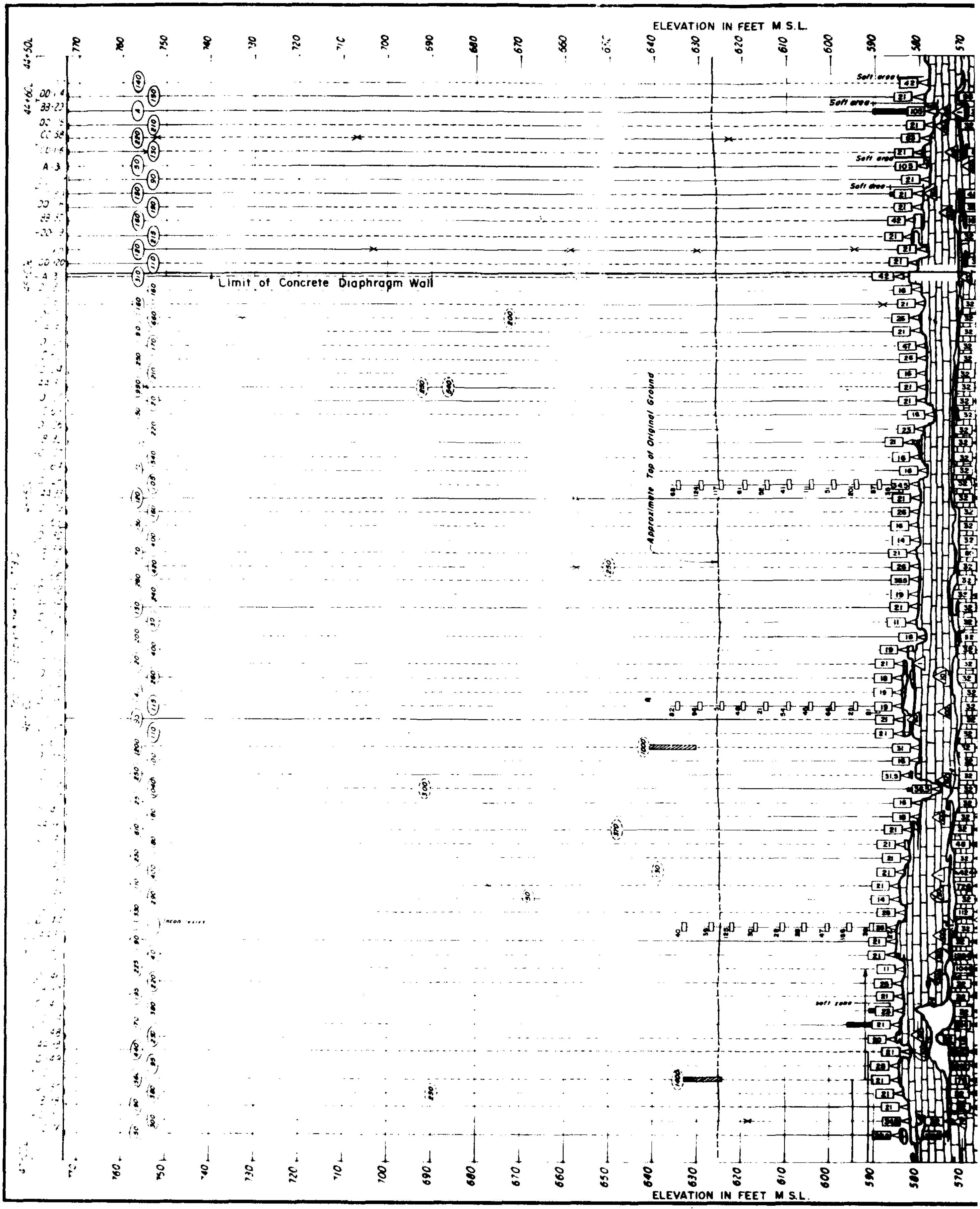
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

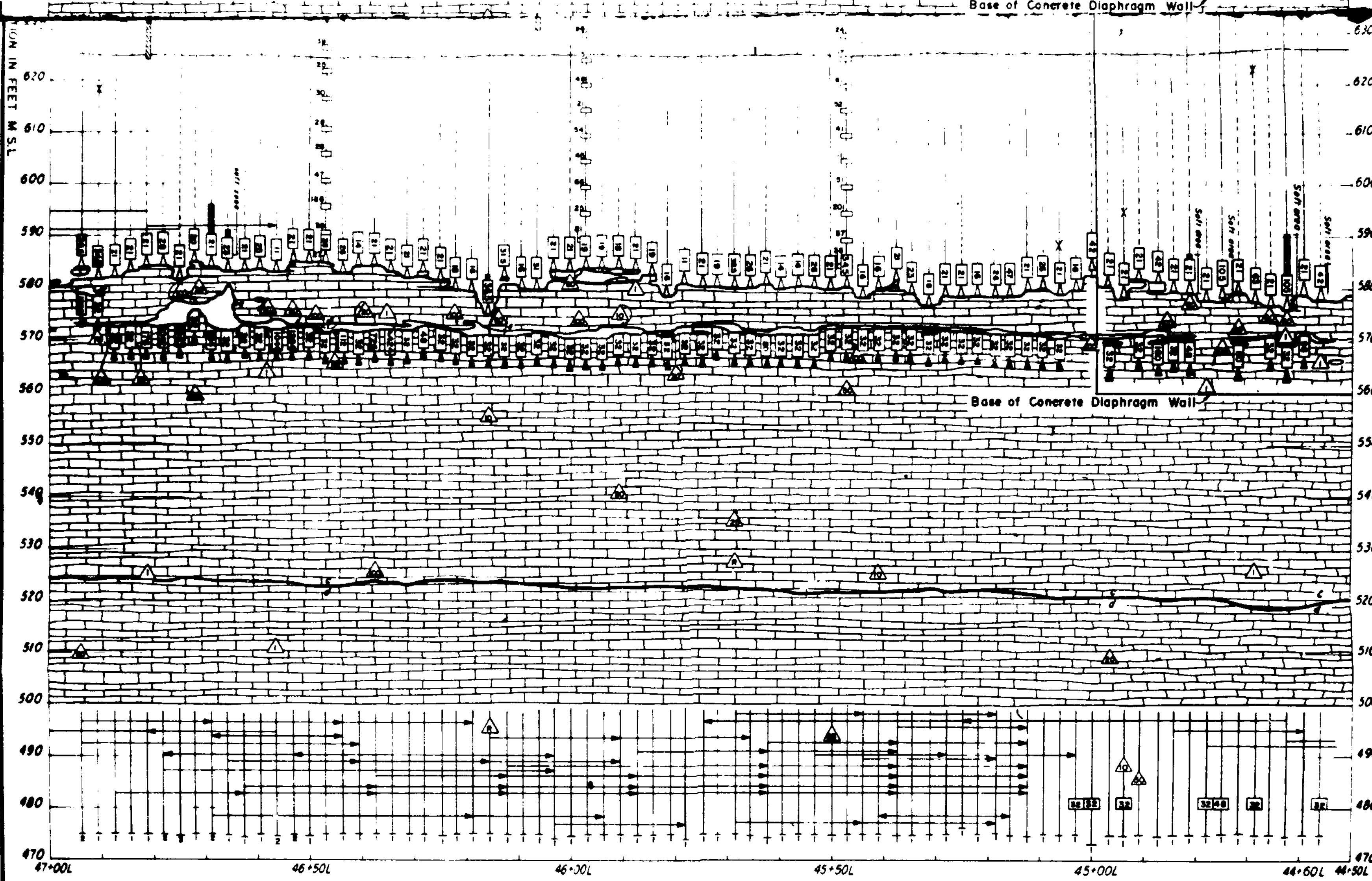
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE II and III
STA 42+10L to 44+60L
GEOLOGIC SECTION

DRAWN CAH
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
DATE APRIL, 1975
SCALE 1" = 10' SPEC NO
DRAWING NUMBER
SHEET OF Q2-52/193

Duane A. Dyer 7 May 1981

PLATE A-21 Q2-52/193


ELEVATION IN FEET M.S.L.
Limit of Concrete Diaphragm Wall
Approximate Top of Original Ground
Soft area
Soft area
Soft area
Soft area
soft zone
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Blow-Count-drive-sampled, standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100 % drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG NO Q2-52/187
2. PHASE II 3-1/8' c.c. EXPLORATORY HOLES BEGIN AT STATION 40+50L, EXTEND TO STATION 45+00L AND ARE DESIGNATED BB, CC, AND DD. PHASE I 25' c.c. HOLES EXTEND TO STATION 46+00L AND ARE DESIGNATED A. PHASE III 3-1/8' c.c. EXPLORATORY HOLES BEGIN AT STATION 45+00L AND ARE DESIGNATED B, C, AND D. PHASE III EXPLORATORY HOLES WILL EXTEND TO STATION 74+00L AND ARE BEING DRILLED AT PRESENT
3. EMBANKMENT PORTION OF BB-29 WAS DRILLED WITH AN AIR CIRCULATING DRILL
4. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

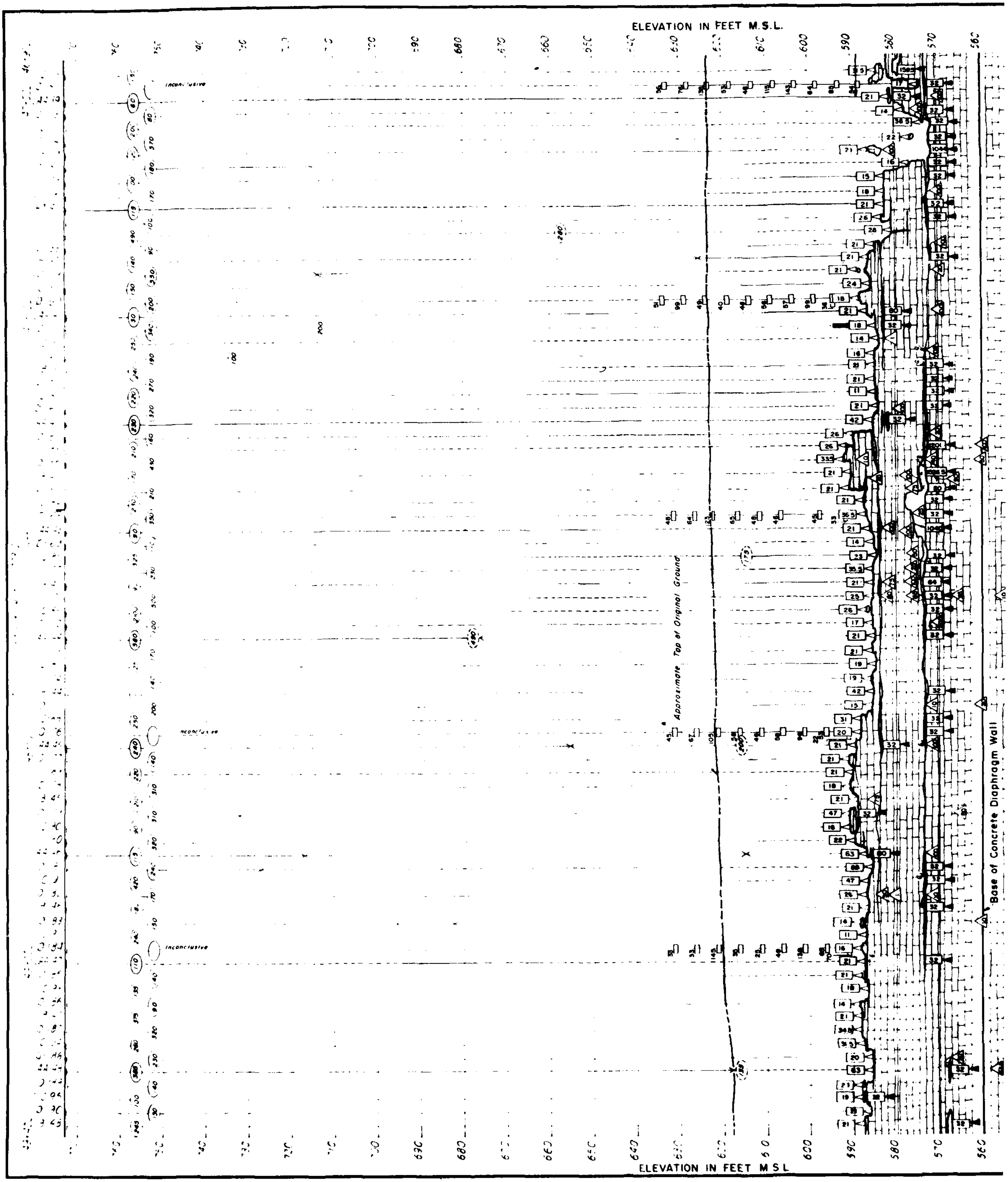
FOUNDATION EXPLORATION - PHASE II and III
STA 44+50L to 47+00L
GEOLOGIC SECTION

DRAWN, CHECKED, TRACED, COMPARED
GEOLOGIST
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
DATE APRIL, 1975
SCALE 1" = 10'
SHEET OF
Q2-52/194

7 Mar 1981

PLATE A-22

Q2-52/194



ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
Base of Concrete Diaphragm Wall
Inconclusive
ELEVATION IN FEET M.S.L.

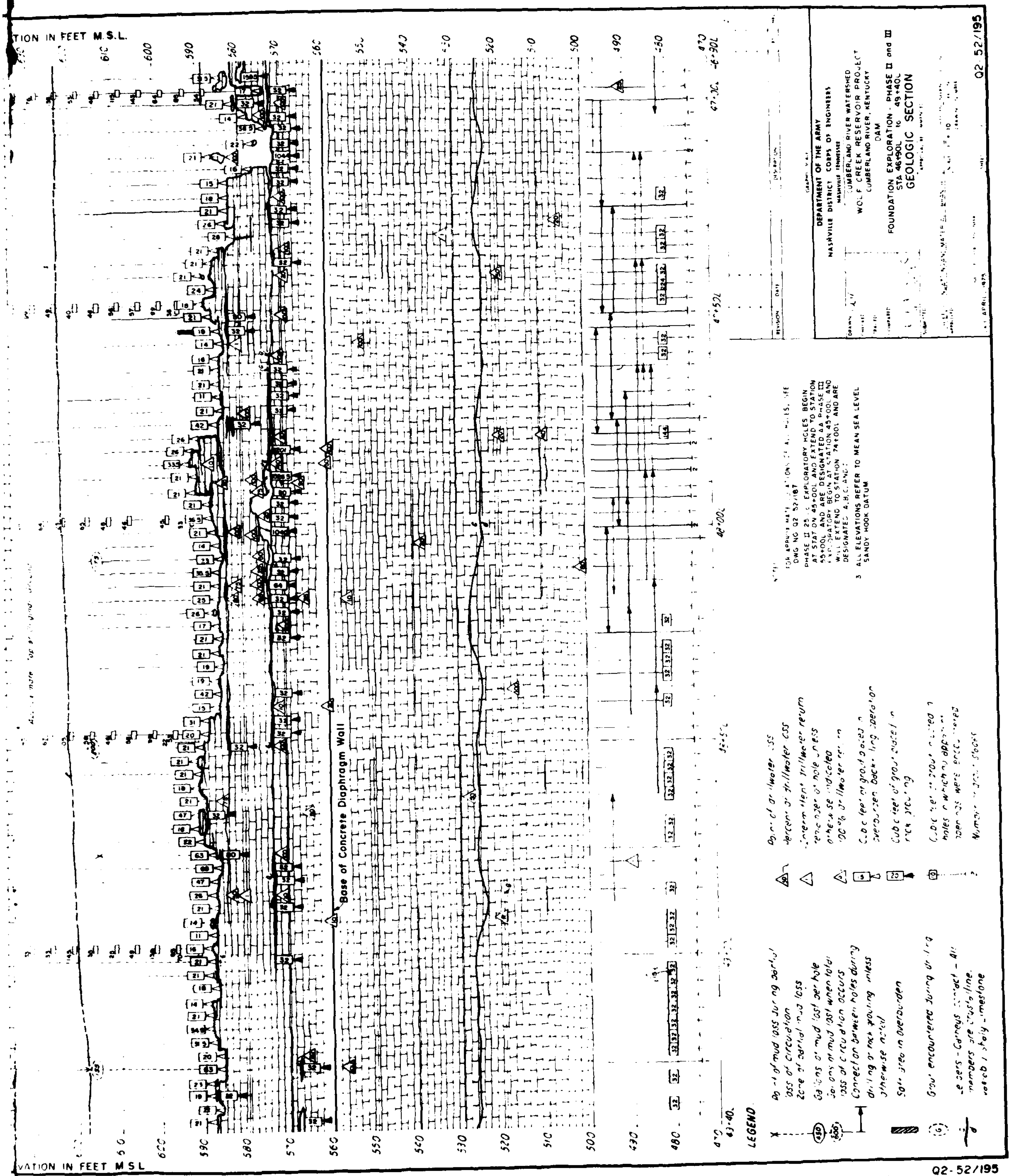
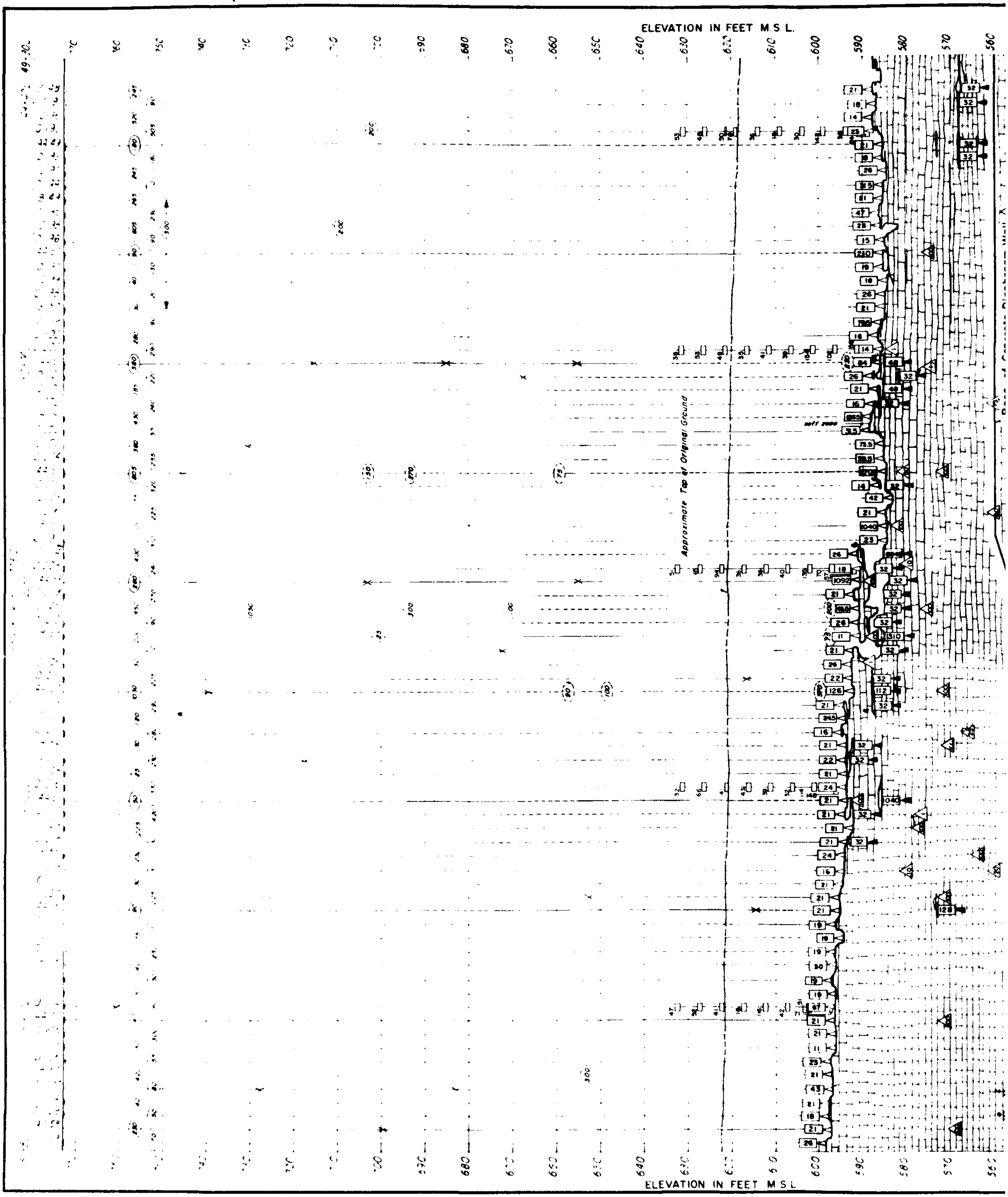
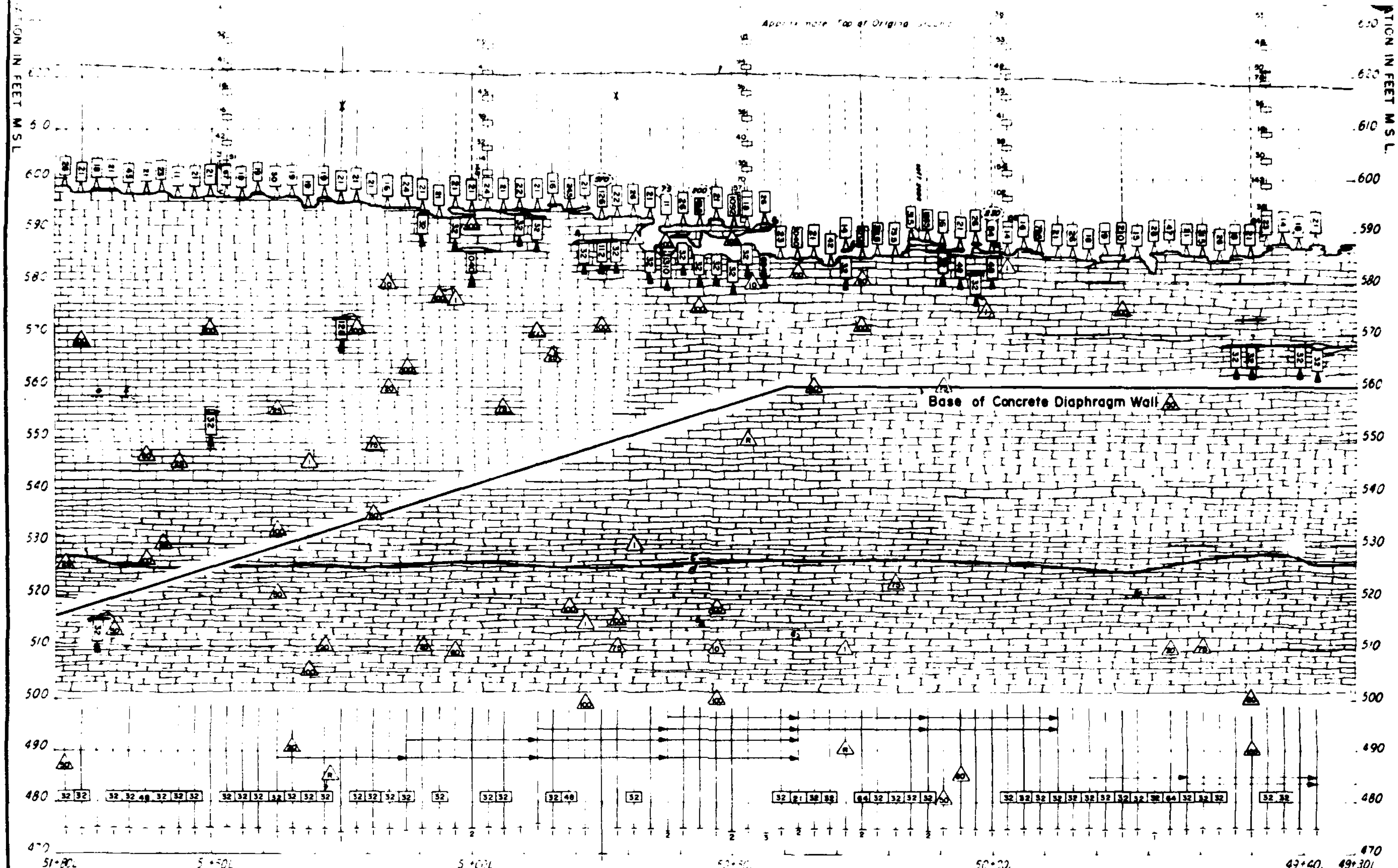


PLATE A-23

Q2-52/195


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
soft zone
ELEVATION IN FEET M.S.L.



LEGEND

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Ledgers - Catheys contact - All members are crystalline, variably shaly limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100 % drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout placed in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG. NOS. Q2-52/187 and 188
2. PHASE II 25 ... EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND WILL EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D
3. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

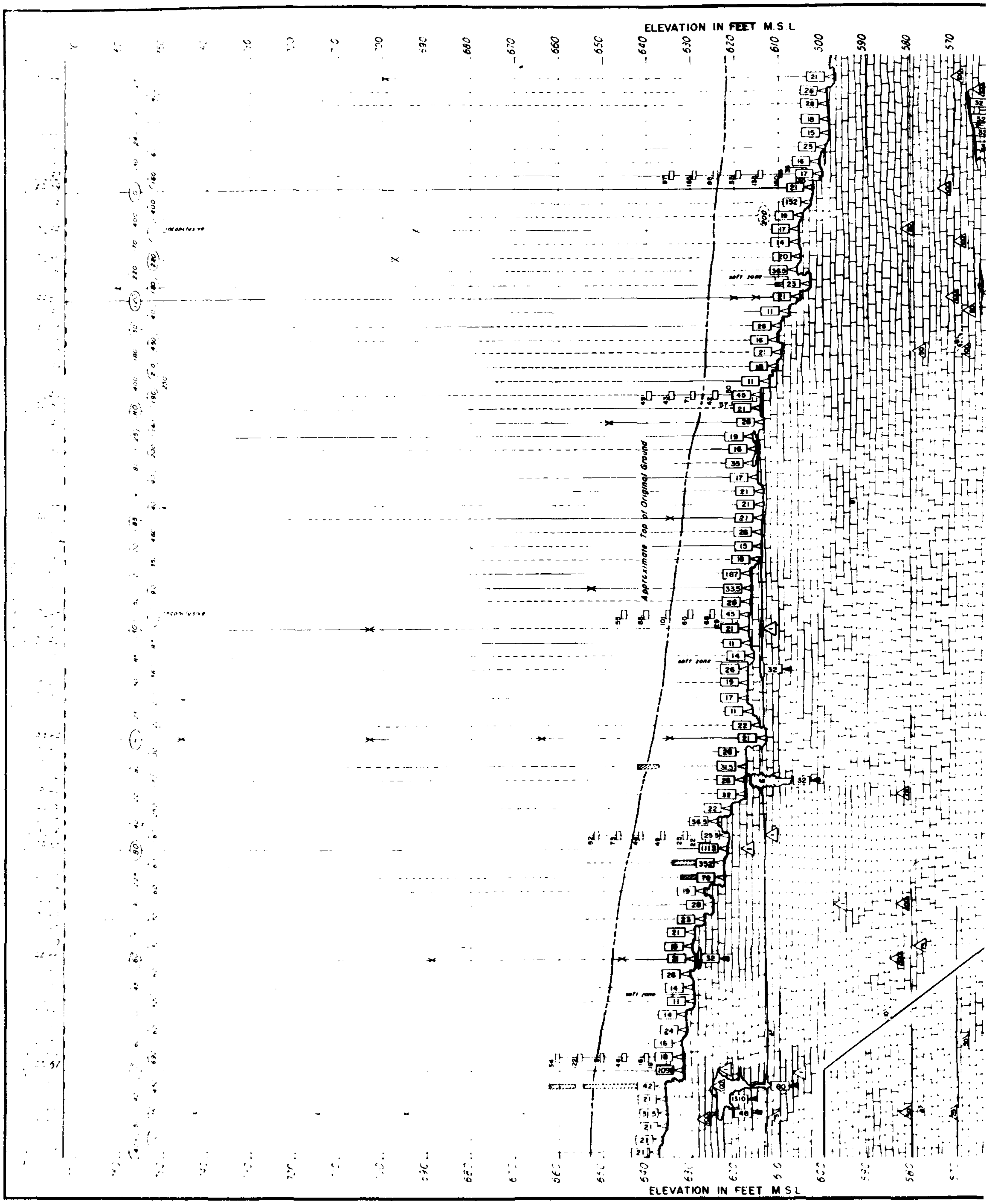
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

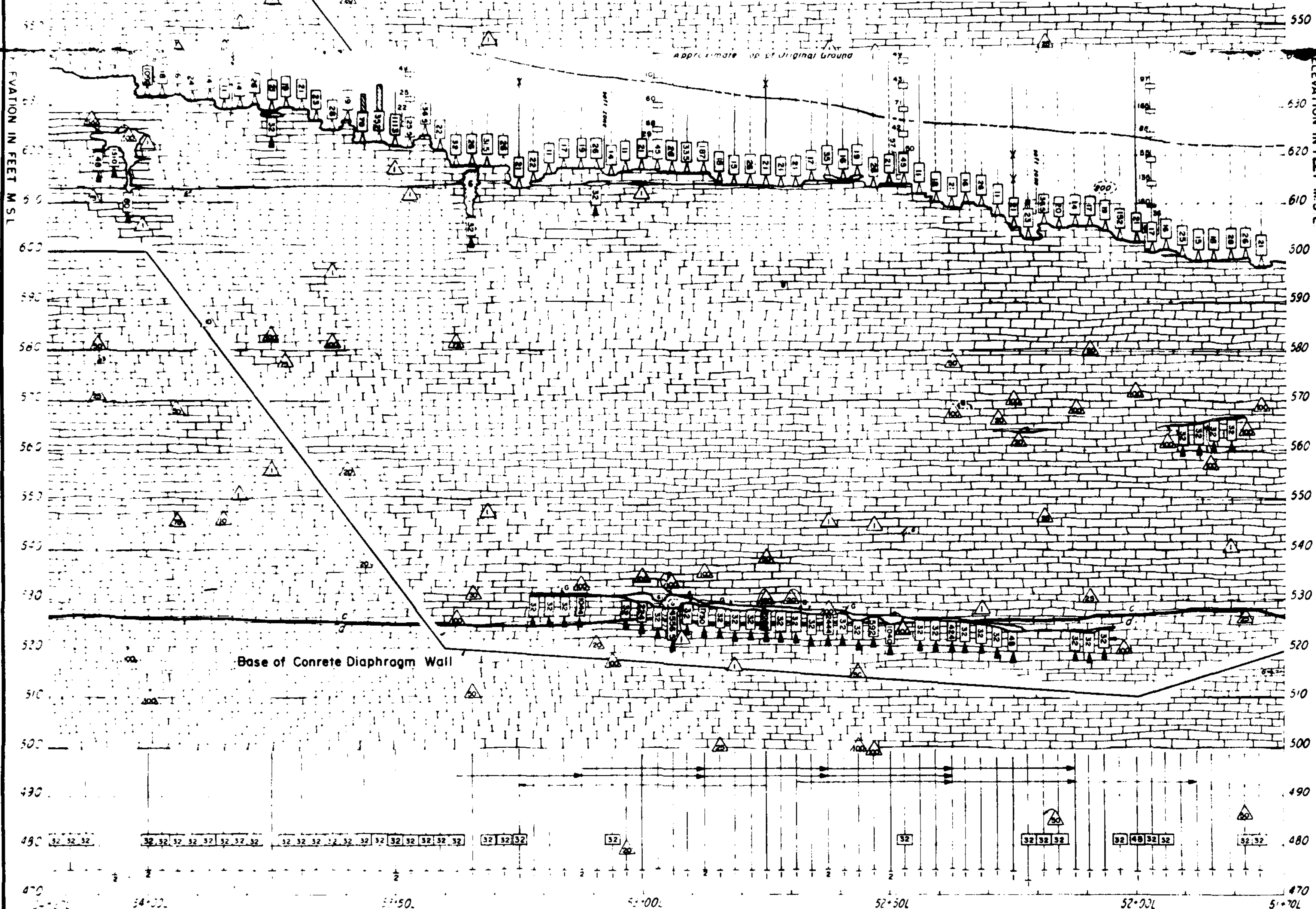
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

FOUNDATION EXPLORATION - PHASE II and III
STA 49+30L to 51+80L
GEOLOGIC SECTION

DRAWN
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
APPROVAL RECOMMENDED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL ... DISTRICT ENGINEER
SCALE 1" = 10'
SPEC NO
DRAWING NUMBER
DATE APR ... 975
SHEET OF
Q2-52/196

PLATE A-24 Q2-52/196


ELEVATION IN FEET M.S.L
Approximate Top of Original Ground
soft zone
inconclusive
ELEVATION IN FEET M.S.L



LEGEND

- Point of mud loss during drilling
- Standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact — All members are crystaline, variably cherty limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

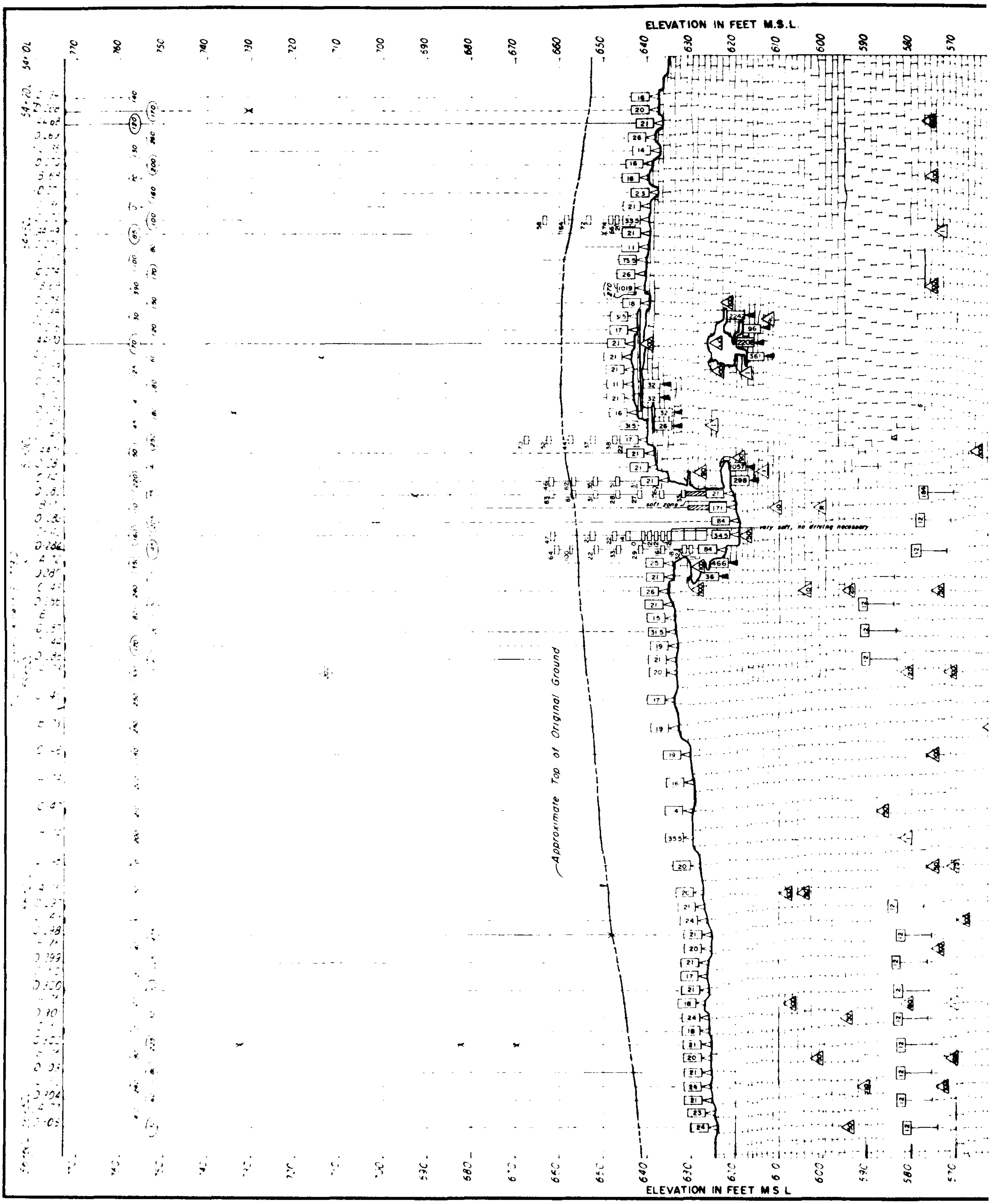
1. FOR APPROXIMATE LOCATIONS OF ALL HOLES SEE DWG NO Q2 52/188
2. PHASE II 25' c.c. EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND WILL EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D
3. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

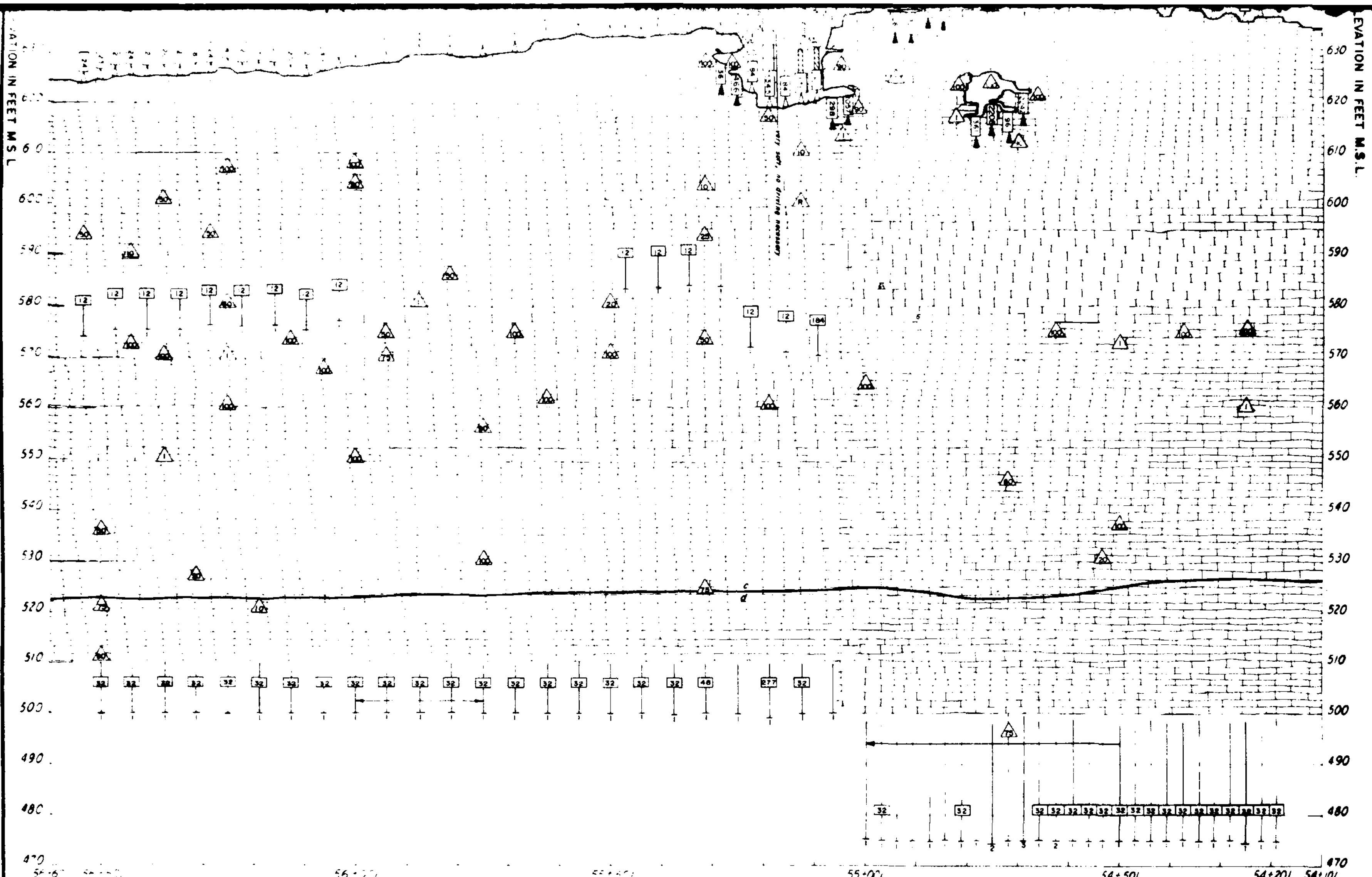
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT. CORPS OF ENGINEERS
NASHVILLE TENNESSEE
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE III
STA 51+70L to 54+20L
GEOLOGIC SECTION

GEOLOGIST

Q2-52/197

PLATE A-25 Q2-52/197


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
soft zone
very soft, no driving necessary
ELEVATION IN FEET M S L



LEGEND

- Point of mud loss during drilling
- Zone of partial mud loss
- Blow-counts, drive sample penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline variably shaly limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE
2. HOLE 138 INTERCEPTED HOLE AA 70 AT ELEVATION 516 6 AND REMAINED IN AA-70 TO BOTTOM OF HOLE
3. WHILE BACKFILLING HOLE C 138 GROUT SURFACED ALONG THE DOWNSTREAM TOE OF THE DAM AT STA 56+36 3, 4+05 68 at EL 640 7
4. PHASE II 25 cc EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND WILL EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D
5. ALL 3-1/8 FOOT C C HOLES BETWEEN STA 55+00L AND STA 58+00L WERE DRILLED 50 FEET INTO ROCK AND THE ROCK PORTION OF EACH HOLE WAS BACKFILLED WITH NEAT CEMENT GROUT ALL REMAINING HOLES WERE BACKFILLED WITH SANDED GROUT
6. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

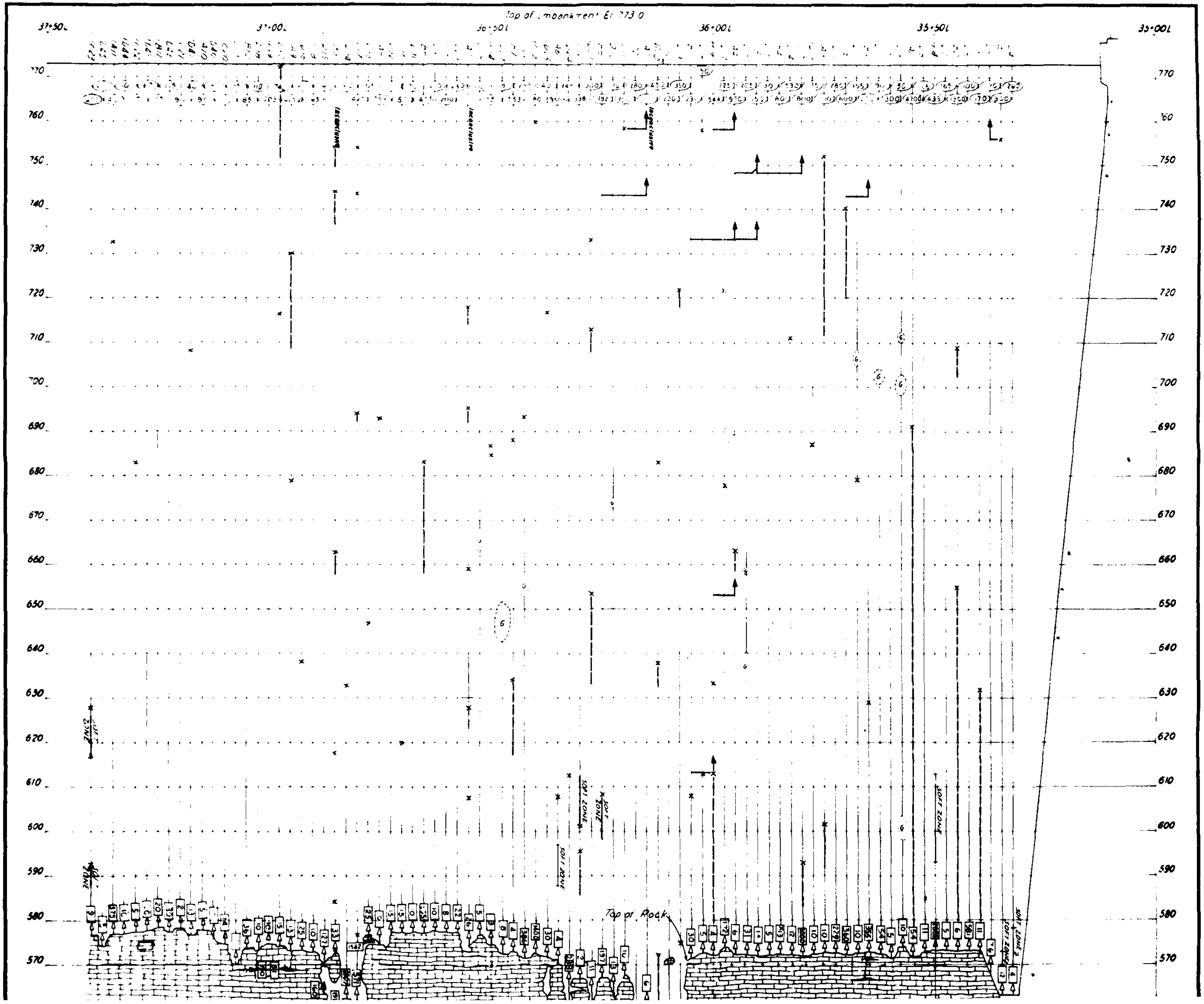
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

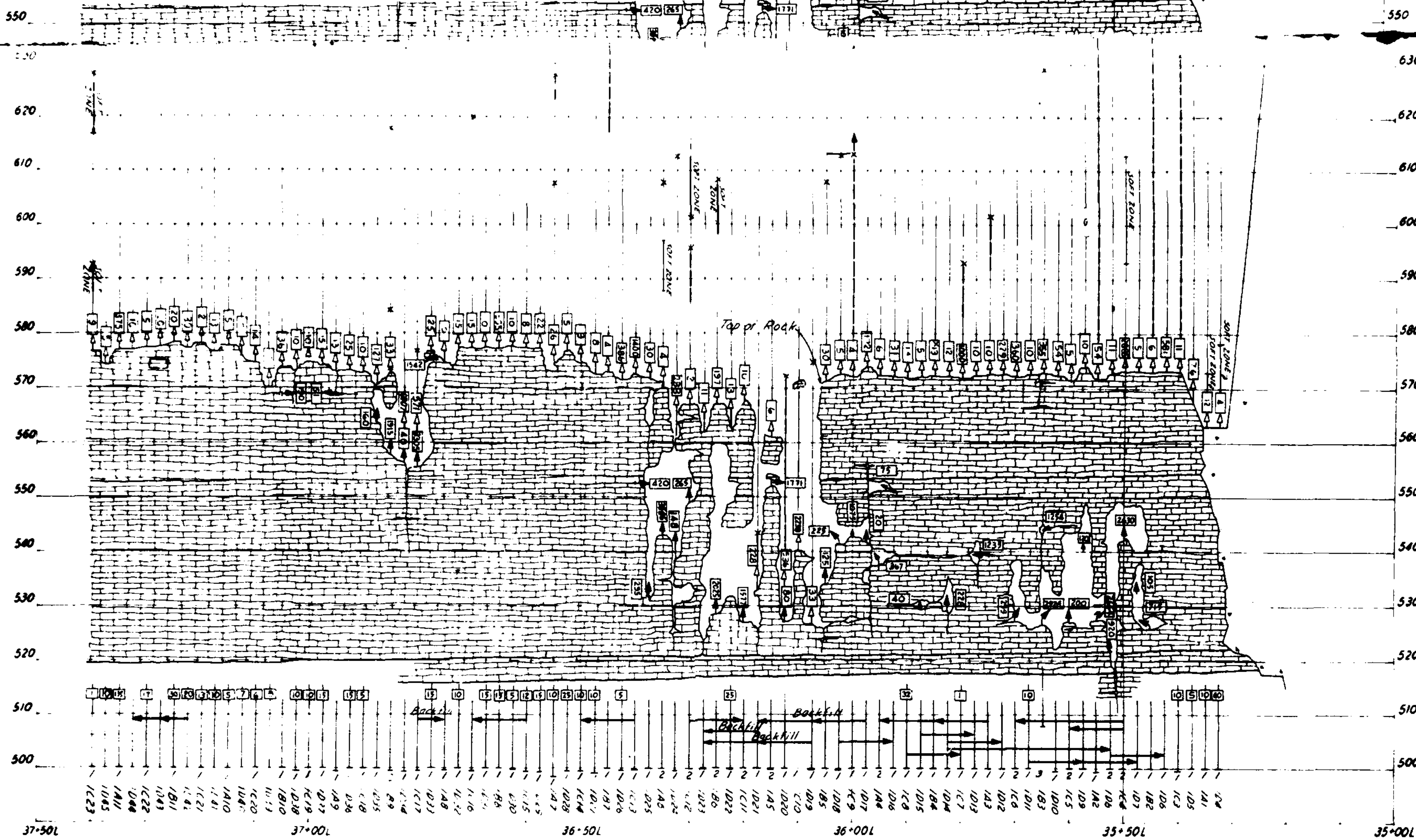
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE II and III
STA 54+10L to 56+60L

GEOLOGIC SECTION

DRAWN: KY
CHECKED:
TRACED:
COMPARED:
GEOLOGIST
SUBMITTED:
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED:
APPROVED:
COLONEL C E DISTRICT ENGINEER
DATE
SCALE 1" = 10'
SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/198



Top of Embankment El 773.0
37+50L
37+00L
36+50L
36+00L
35+50L
35+00L
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
SOFT ZONE
Inconclusive
Top of Rock



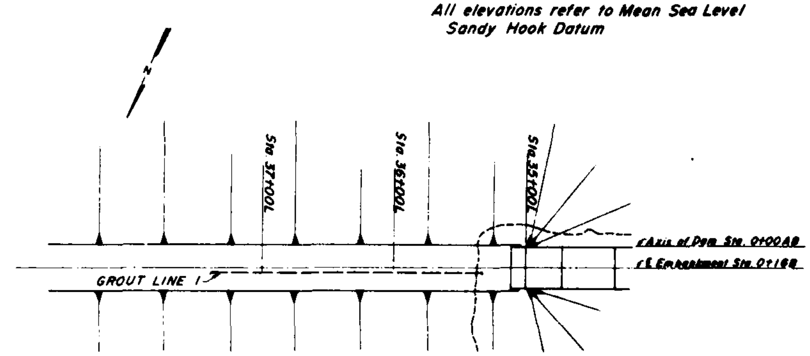
NOTE:
All elevations refer to Mean Sea Level Sandy Hook Datum

LEGEND

- Mud lost
- No mud return
- Partial mud return

For details see logs of individual borings

- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered.
- Number of grout stages
- Gallons of mud lost per hole
- Pounds of mud lost per hole
- Connection between holes during drilling or rock grouting unless otherwise noted
- Grout encountered during drilling



LOCATION PLAN
SCALE 1"=80'

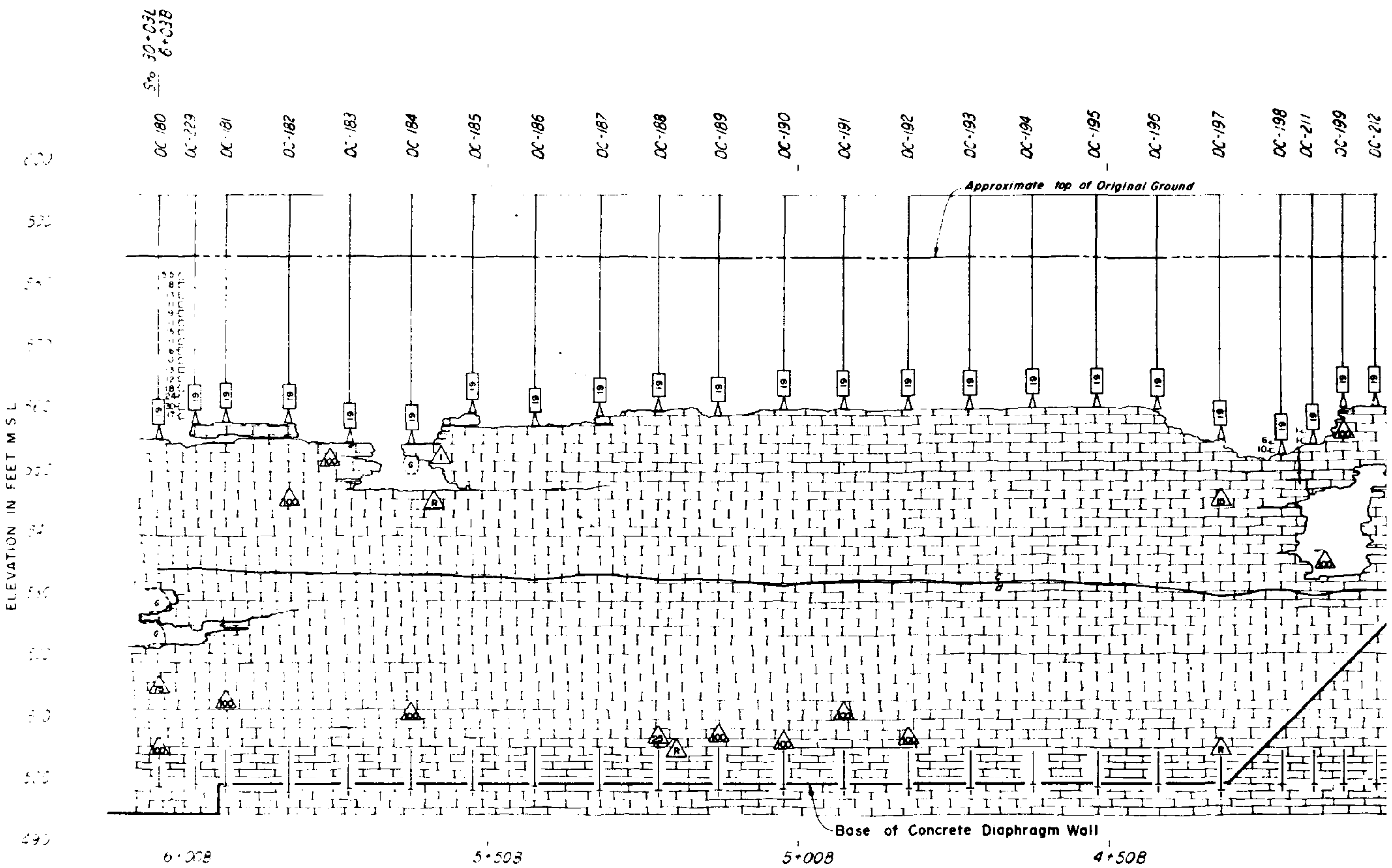
REVISION	DATE	DESCRIPTION	BY	CHKD

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION GROUTING - LINE 1
GEOLOGIC SECTION

DRAWN: / CHECKED: / TRACED: / COMPARED: / SUBMITTED / APPROVED
CHIEF, FOUNDATION AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
COLONEL, C. E. DISTRICT ENGINEER
DATE APRIL, 1979
SCALE 1" = 10'
SHEET OF
Q2-52/199

PLATE A-27



LEGEND

Blow-Counts - drive sample, standard penetration

Connection between holes during drilling or pressure testing unless otherwise indicated

Grout encountered during drilling

$\frac{c}{d}$ Leipers - Catheys contact - All members are crystalline, variably shaly Limestone

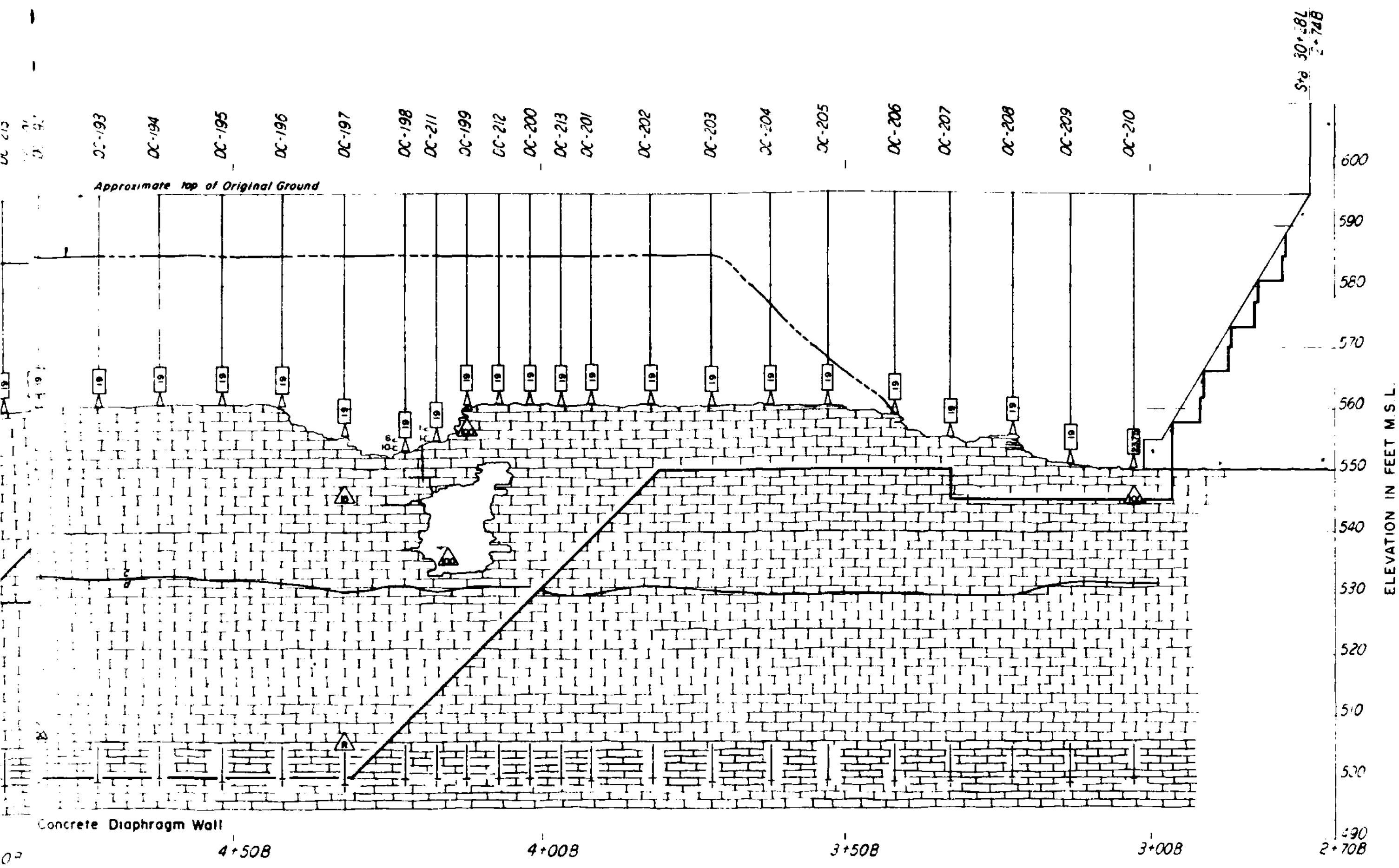
Point of drillwater loss
Percent of drillwater loss

Intermittent drillwater return remainder of hole unless otherwise indicated

100% drillwater return

Cubic feet of grout placed during backfilling operation. There was no differentiation made between rock and overburden

Number of grout stages



NOTES

1. *For locations of all holes see Dwg. No Q2-52/189*
2. *All elevations refer to Mean Sea Level, Sandy Hook Datum.*

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION – SWITCHYARD
GEOLOGIC SECTION

GEOLOGIST

SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH

APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION

APPROVED
COLONEL, C. E. DISTRICT ENGINEER

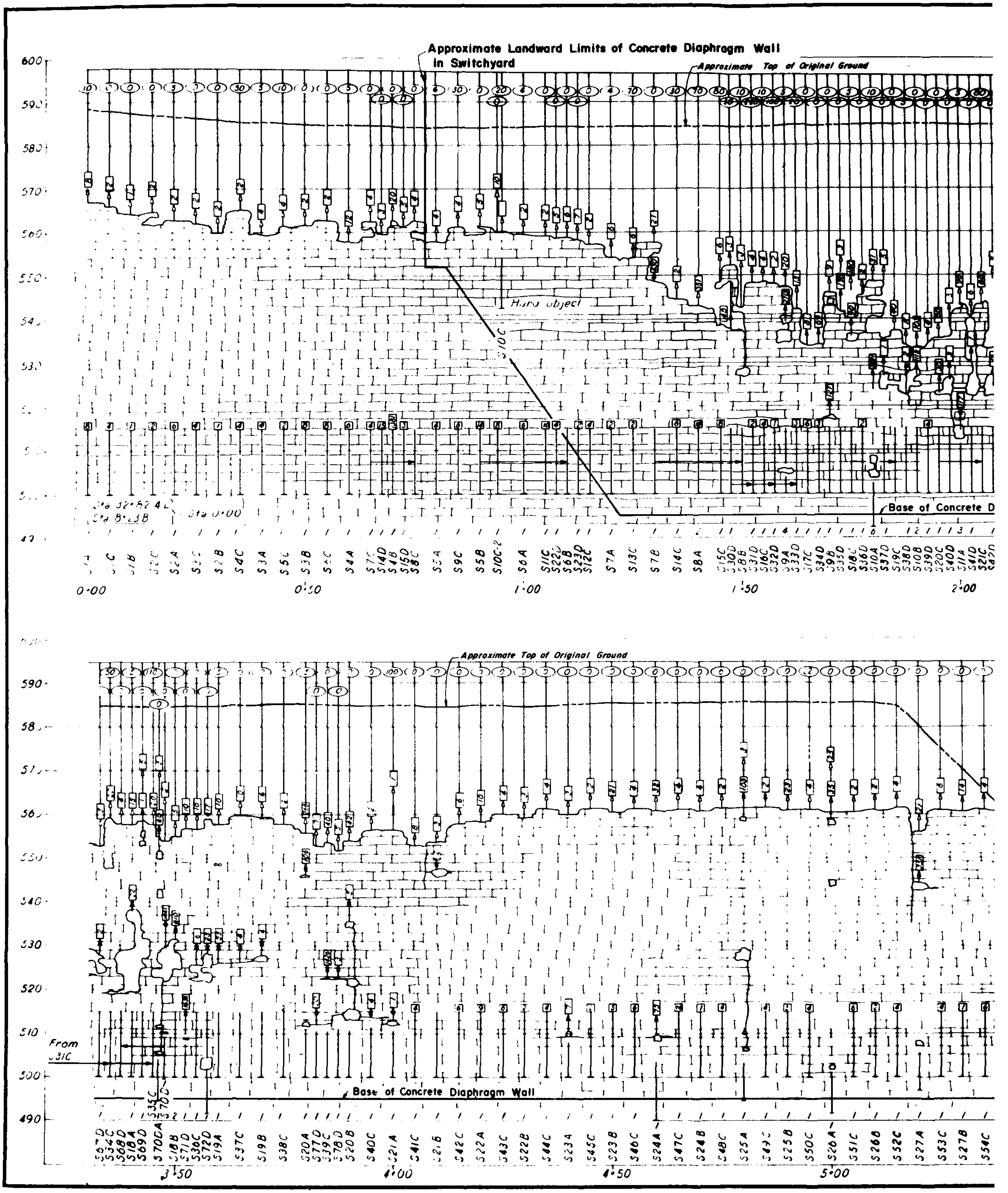
SCALE 1" = 10' | SPEC. NO.
DRAWING NUMBER

DATE: APRIL, 1978

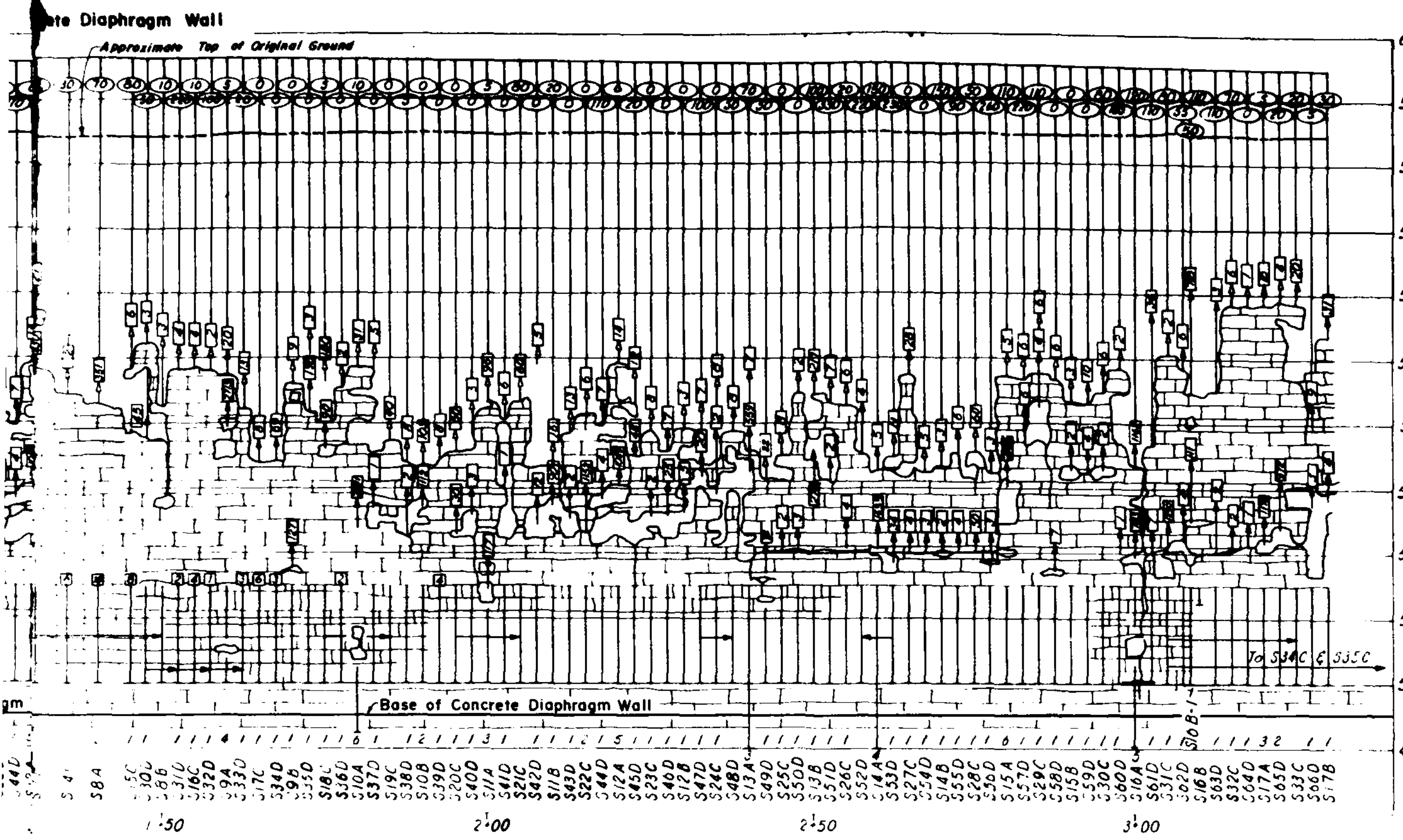
SHEET OF Q2-52/200

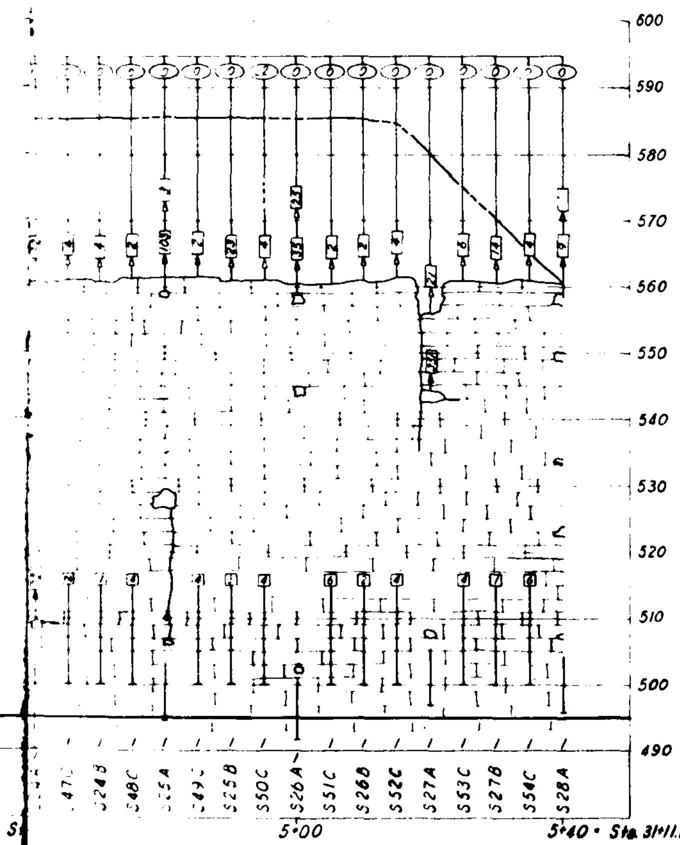
PLATE A-28

7 May 1981



Approximate Landward Limits of Concrete Diaphragm Wall in Switchyard
Approximate Top of Original Ground
Hard object
Base of Concrete D
Sta 32+62.4 L
Sta 8+23B
Sta 0+00
0+00
0+50
1+00
1+50
2+00
600
590
580
570
560
550
540
530
Approximate Top of Original Ground
From
S31C
Base of Concrete Diaphragm Wall
3+50
4+00
4+50
5+00
590
580
570
560
550
540
530
520
510
500
490





LEGEND

	No mud return	For details, see logs of individual borings
	Partial mud return	
	Cubic feet of grout placed in overburden backfilling operation	
	Cubic feet of grout placed in rock grouting	
	Cubic feet of grout injected in holes in which no apparent openings were encountered	
	Number of grout stages	
	Gallons of mud lost per hole	
	Connection between holes during drilling or rock grouting unless otherwise noted	

NOTES:

1. For locations of all holes see Dwg. No. Q2-52/189.
2. All elevations refer to Mean Sea Level, Sandy Hook Datum

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

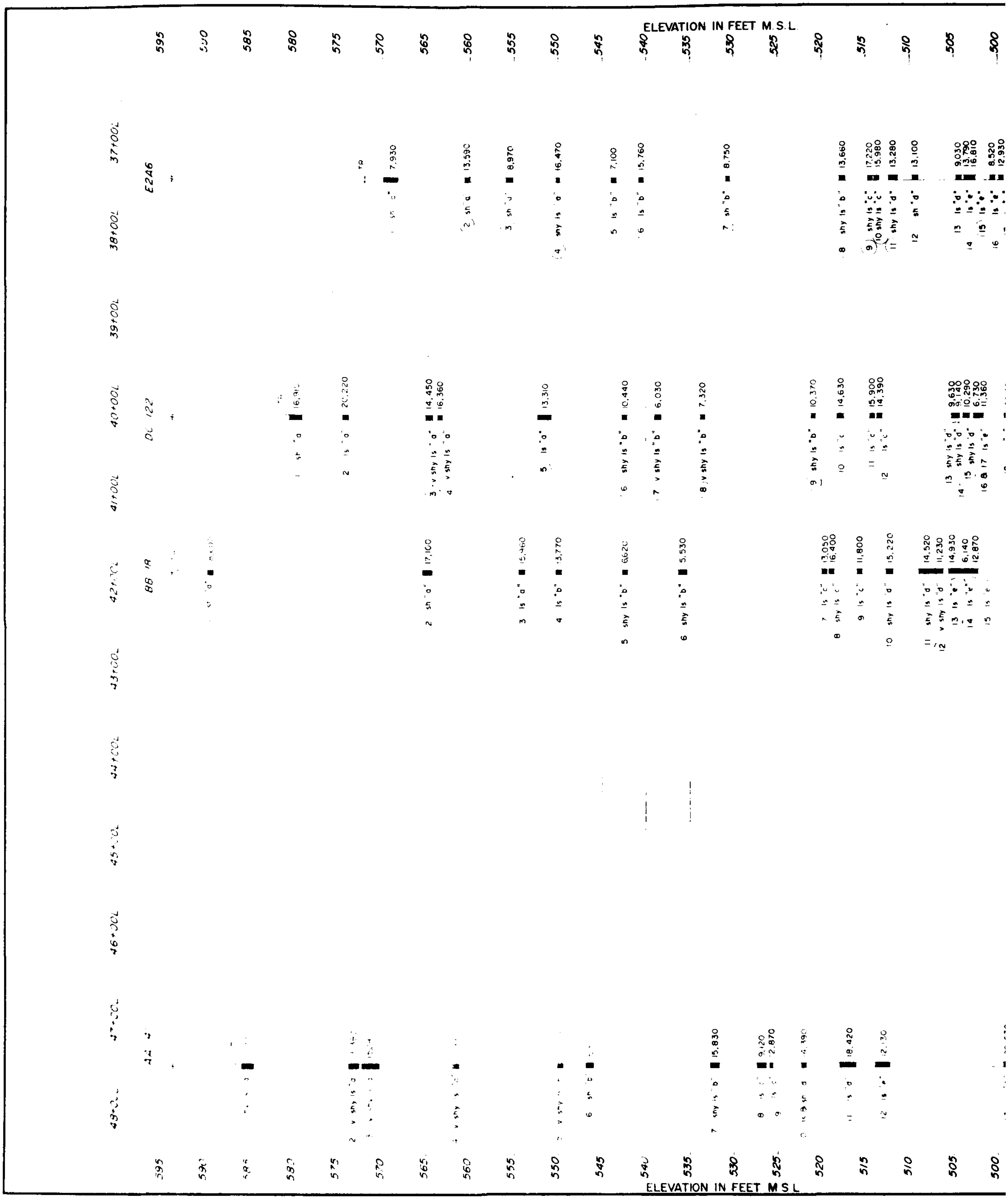
DRAWN BRC
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION GROUTING
SWITCHYARD
GEOLOGIC SECTION

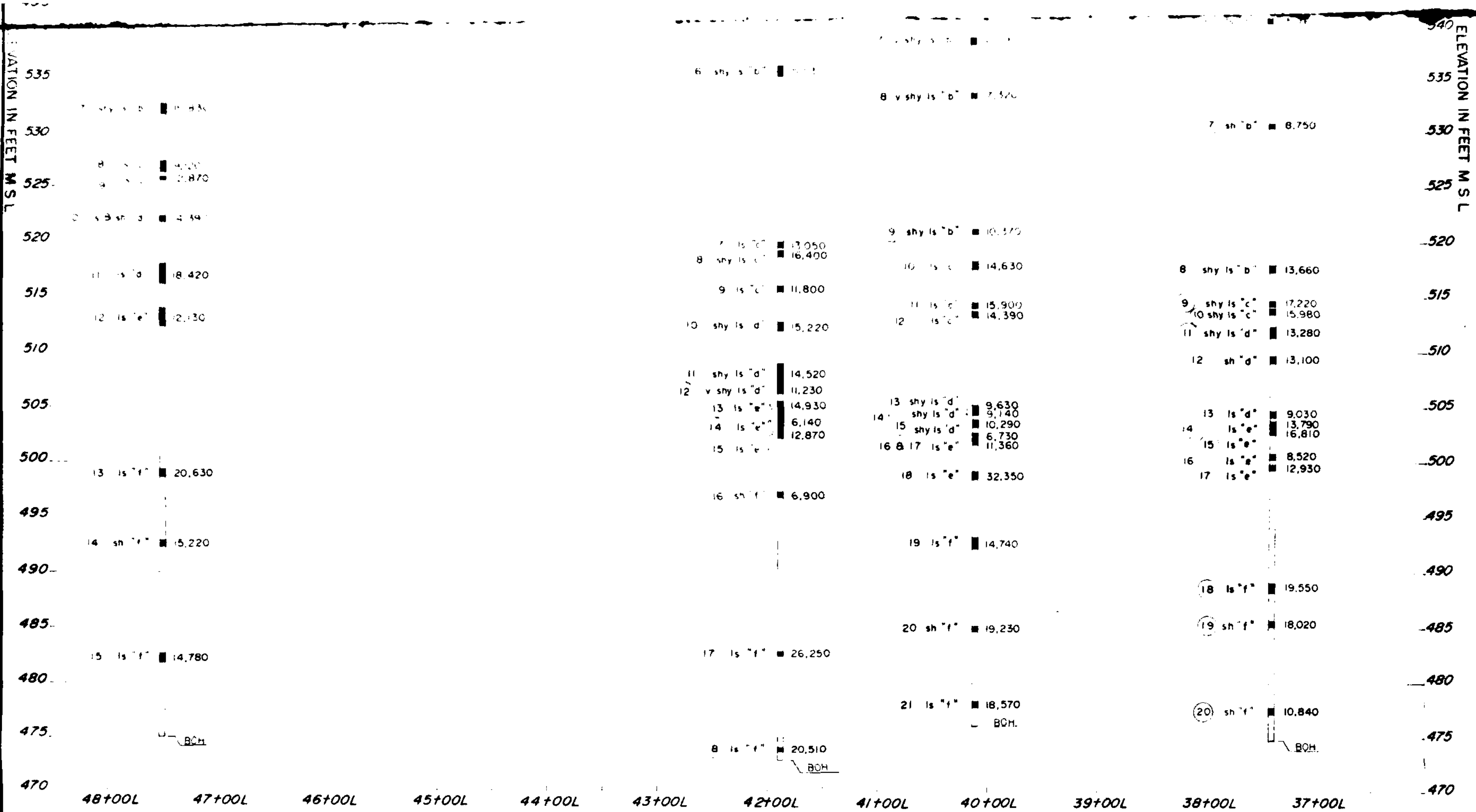
F. H. Swartz
GEOLOGIST
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E DISTRICT ENGINEER

DATE APRIL, 1975
SCALE 1" = 10'
SHEET OF
Q2-52/201

PLATE A-29



ELEVATION IN FEET M.S.L.
595
585
580
575
570
565
560
555
550
545
540
535
530
525
520
515
510
505
500
37+00
38+00
39+00
40+00
41+00
42+00
E2A6
DC 122
BB 1R
ELEVATION IN FEET M.S.L.



UNCONFINED COMPRESSIVE STRENGTHS

SCALE 1" = 5' VERT 1" = 50' HORIZ

LEGEND

GENERAL GEOLOGIC DESCRIPTION

ABBREVIATIONS

1 For locations of all holes see Dwg Nos Q2-52/186, 187

2 All compressive strengths are unconfined

3 For detailed geologic logs for holes shown see Volume II Plans and Specifications

4 All elevations refer to Mean Sea Level, Sandy Hook Datum

REVISION	DATE	DESCRIPTION	BY	CHKD

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

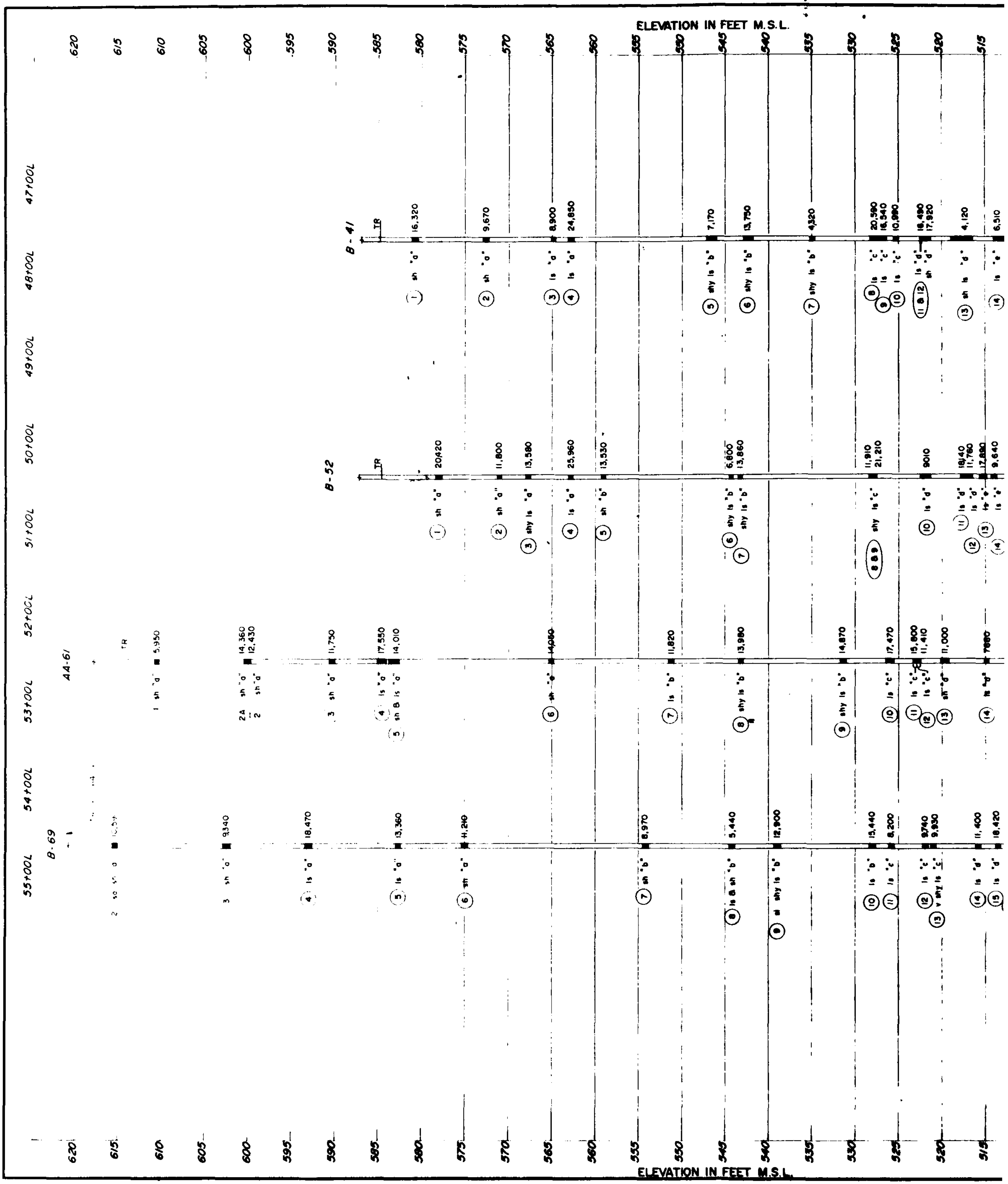
DIAPHRAGM WALL – AXIS ALIGNMENT
UNCONFINED COMPRESSIVE STRENGTHS – ROCK CORE

CHIEF, FOUNDATIONS AND MATERIALS BRANCH

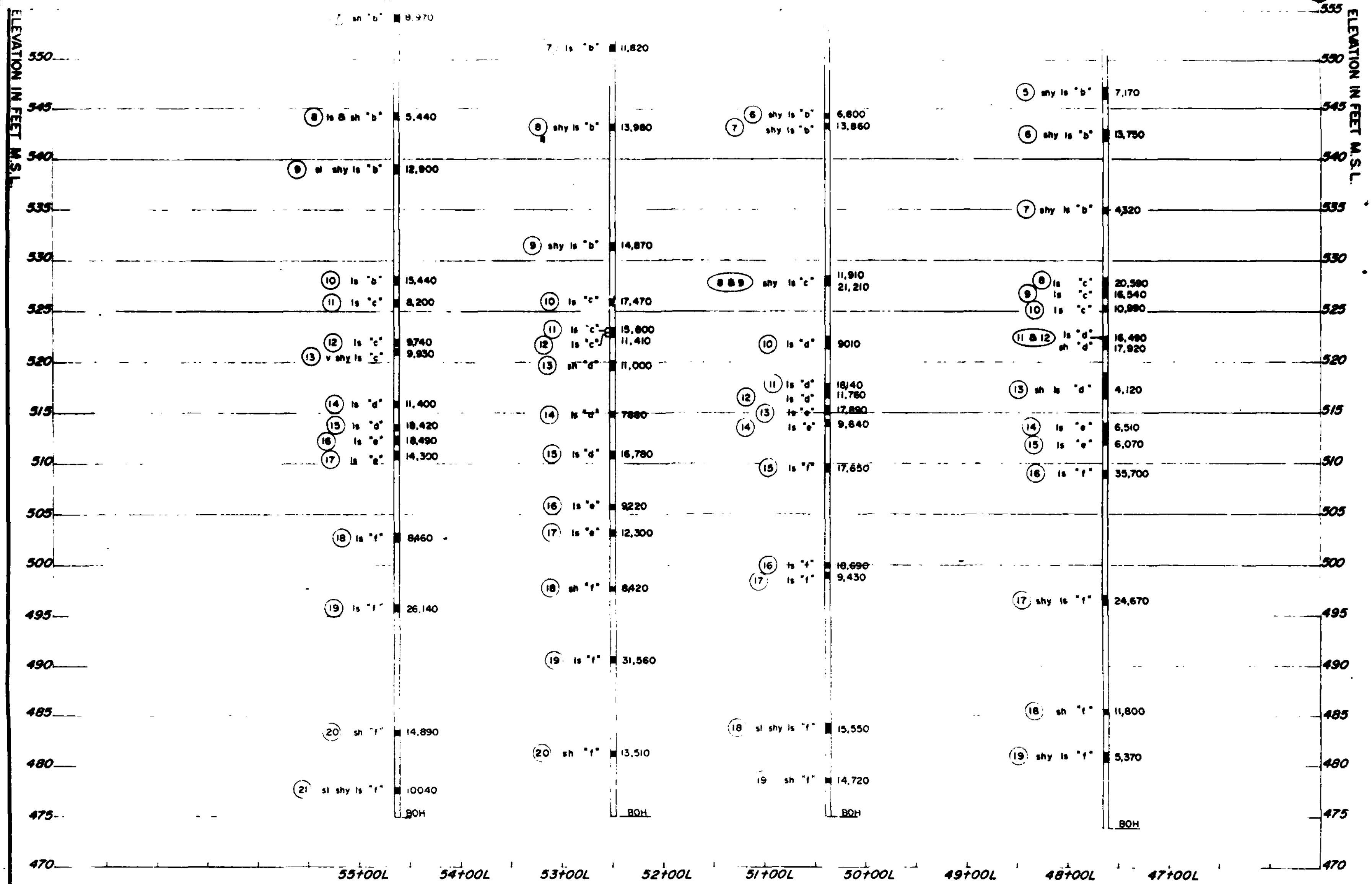
Q2-52/202

PLATE A-30

Q2-52/202



ELEVATION IN FEET M.S.L.
620
615
610
605
600
595
590
585
580
575
570
565
560
555
550
545
540
535
530
525
520
515
47+00L
48+00L
49+00L
50+00L
51+00L
52+00L
53+00L
54+00L
55+00L
B-41
B-52
AA-61
B-69
TR
ELEVATION IN FEET M.S.L.



UNCONFINED COMPRESSIVE STRENGTHS

SCALE 1" = 5' VERT 1" = 50 HORIZ

LEGEND

TOP OF ROCK — TR

SAMPLE NO — (2)

GENERAL GEOLOGIC DESCRIPTION — shy ls

GEOLOGIC MEMBER — "a"

ROCK SAMPLE

COMPRESSIVE STRENGTH (P S I) — 11,300

BOTTOM OF HOLE — BOH

ABBREVIATIONS

sl	slightly
shy	shaly
ls	limestone
v	very
sh	shale

NOTES

1. Sample No 1, hole B-69 was taken between elevations 635 3 and 634 6 and had a compressive strength of 9,490 P S I .
2. For detailed geologic logs for holes shown see Volume II Plans and Specifications
3. All elevations refer to Mean Sea Level, Sandy Hook Datum

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

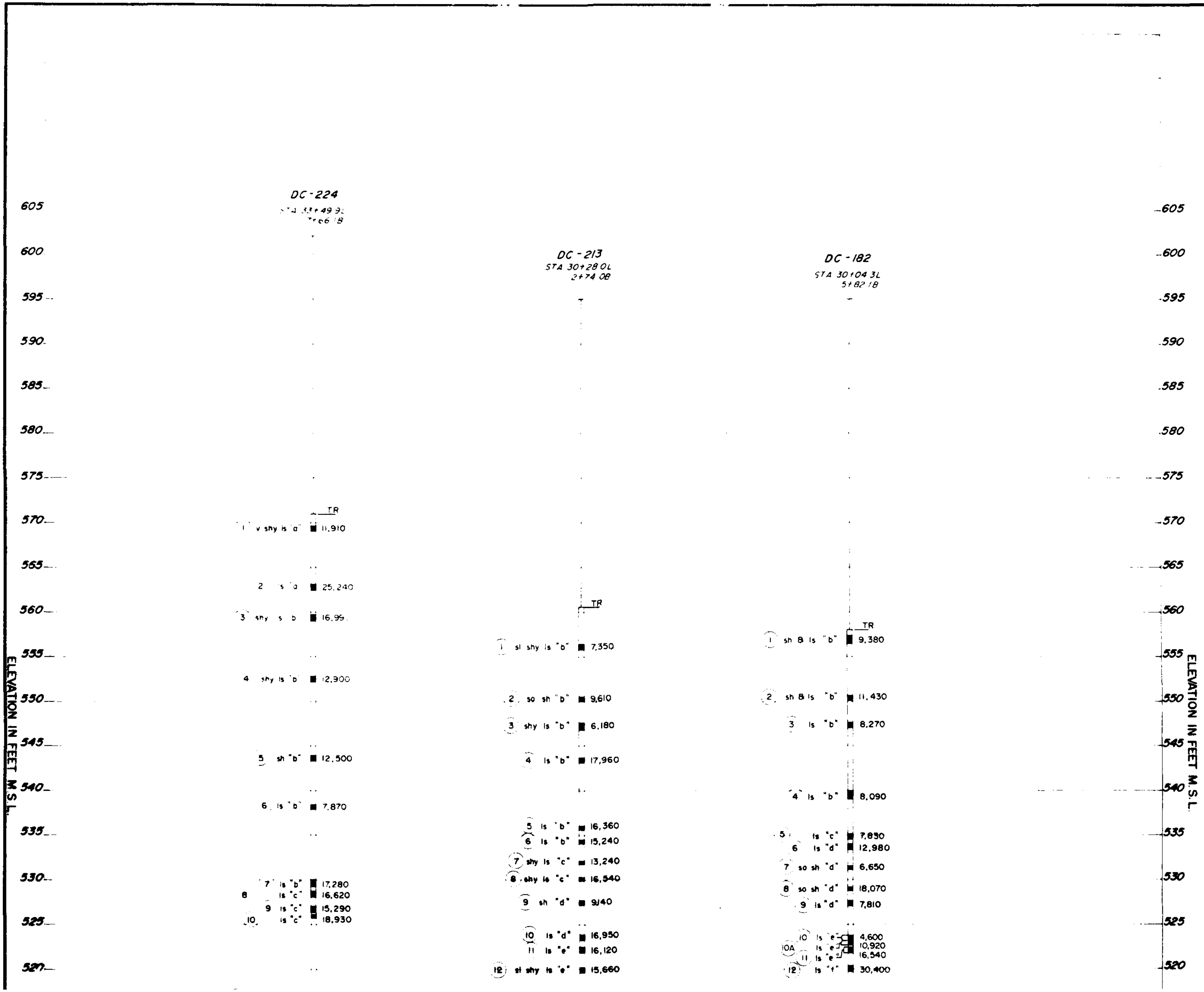
DIAPHRAGM WALL - AXIS ALIGNMENT
UNCONFINED COMPRESSIVE STRENGTHS - ROCK CORE

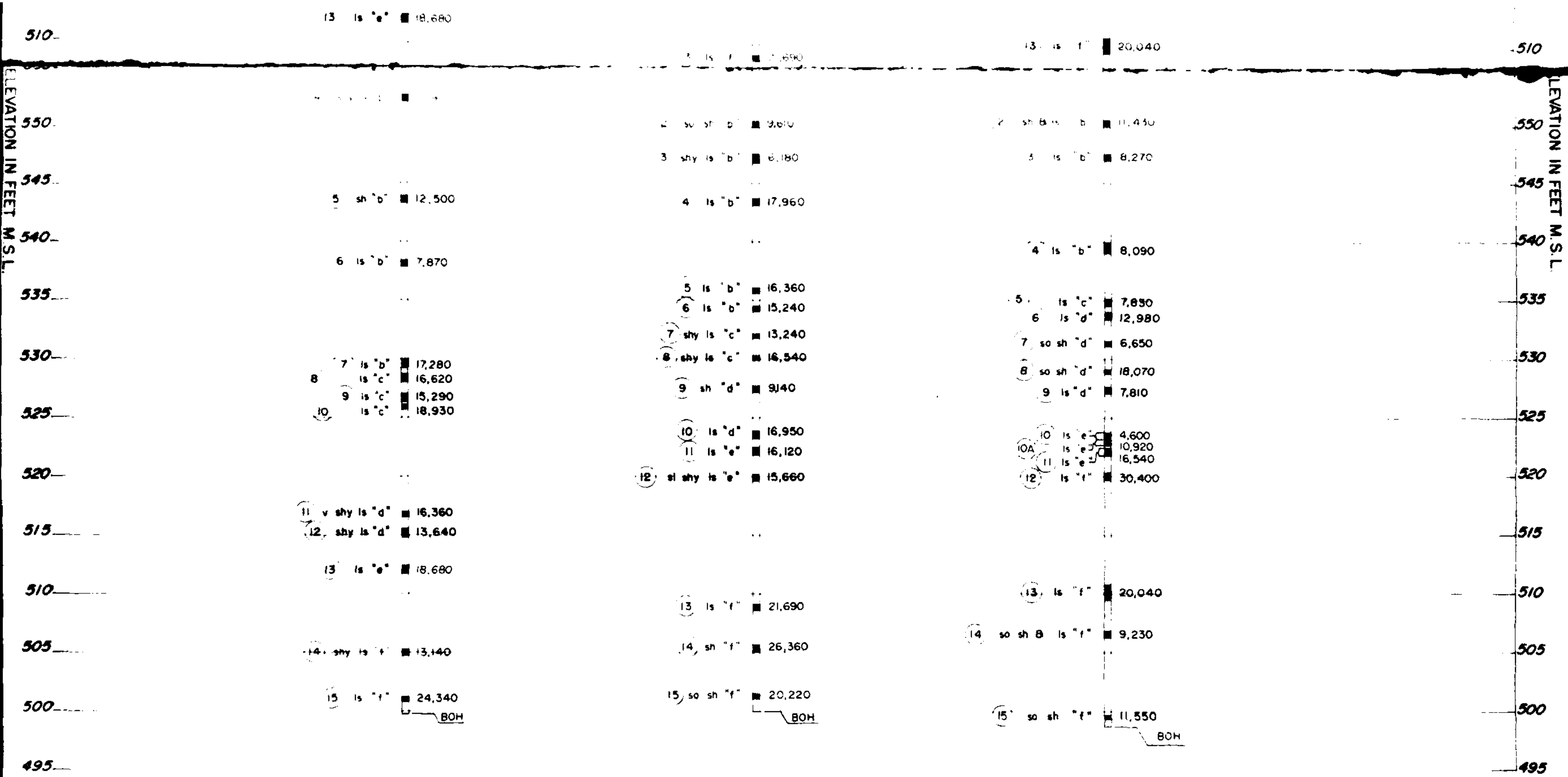
DRAWN
CHECKED
TRACED
COMPARED
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVED
APPROVAL RECOMMENDED
SCALE AS SHOWN

Q2-52/203

PLATE A-31

Q2-52 203


ELEVATION IN FEET M.S.L.
605
600
595
590
585
580
575
570
565
560
555
550
545
540
535
530
525
520
DC-224
DC-213
STA 30+28.0L
2+74.08
DC-182
STA 30+04.3L
5+82.18
TR
v shy ls "a" 11,910
25,240
16,99
shy ls "b" 12,900
sh "b" 12,500
ls "b" 7,870
ls "b" 17,280
ls "c" 16,620
ls "c" 15,290
ls "c" 18,930
sl shy ls "b" 7,350
so sh "b" 9,610
shy ls "b" 6,180
ls "b" 17,960
ls "b" 16,360
ls "b" 15,240
shy ls "c" 13,240
shy ls "c" 16,540
sh "d" 9,140
ls "d" 16,950
ls "e" 16,120
sl shy ls "e" 15,660
sh & ls "b" 9,380
sh & ls "b" 11,430
ls "b" 8,270
ls "b" 8,090
ls "c" 7,830
ls "d" 12,980
so sh "d" 6,650
so sh "d" 18,070
ls "d" 7,810
ls "e" 4,600
10A
ls "e" 10,920
ls "e" 16,540
ls "f" 30,400



UNCONFINED COMPRESSIVE STRENGTHS

SCALE 1" = 5'

LEGEND

TOP OF ROCK	TR
SAMPLE NO	2
GENERAL GEOLOGIC DESCRIPTION	shy ls
GEOLOGIC MEMBER	"a"
ROCK SAMPLE COMPRESSIVE STRENGTH (P.S.I.)	11,300
BOTTOM OF HOLE	BOH

ABBREVIATIONS

s	slightly
shy	shaly
ls	limestone
so	soft
v	very
sh	shale

1 For locations of all holes see Dwg Q2-52/189.
2 All compressive strengths are unconfined.
3 For detailed geologic logs for holes shown see Volume II Plans and Specifications.
4 All elevations refer to Mean Sea Level, Sandy Hook Datum.

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

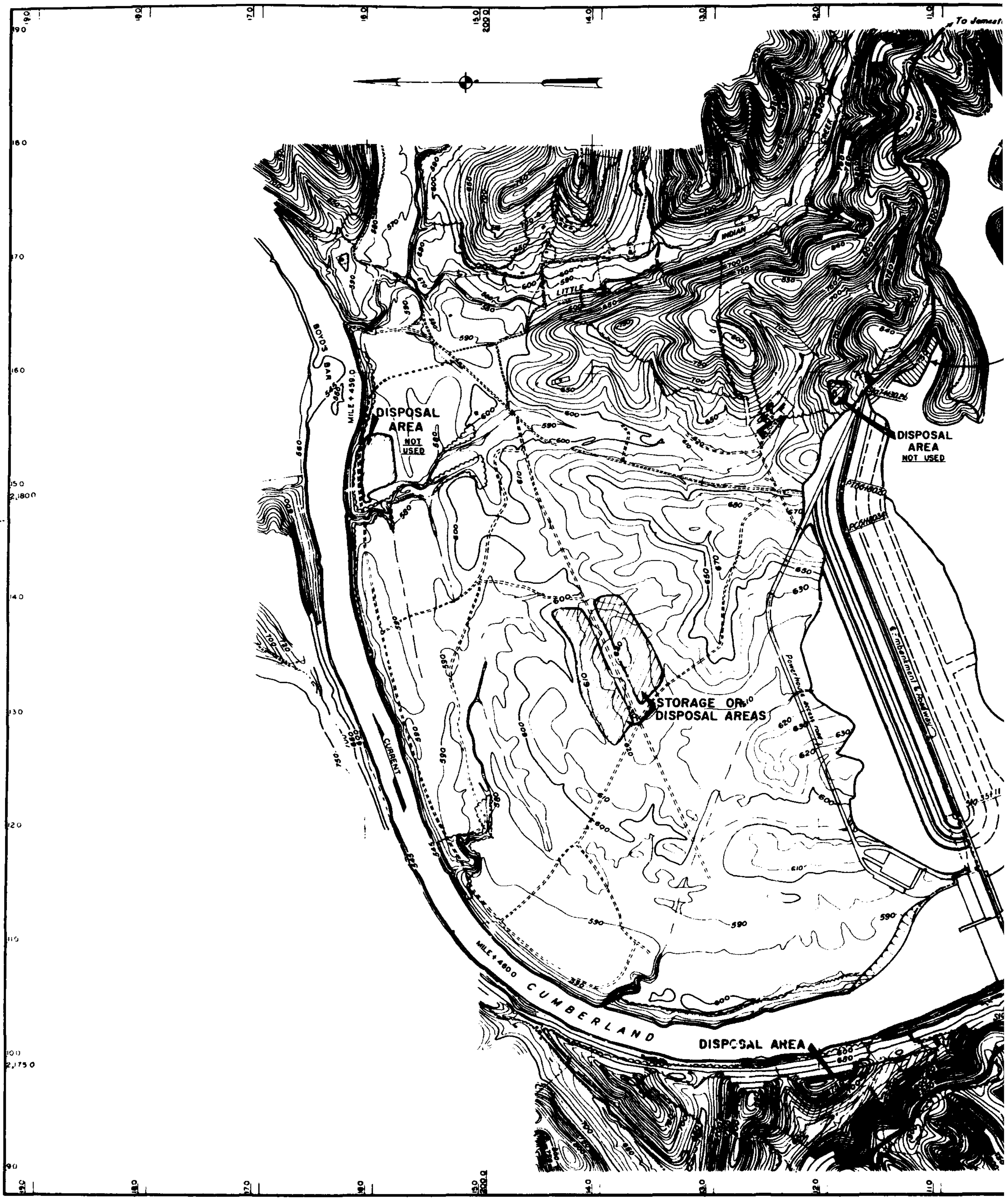
DRAWN
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
DIAPHRAGM WALL - SWITCHYARD
UNCONFINED COMPRESSIVE STRENGTHS - ROCK CORE

SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL C E DISTRICT ENGINEER
SCALE AS SHOWN SPEC. NO
DRAWING NUMBER
DATE APRIL, 1975
SHEET OF
Q2-52/204

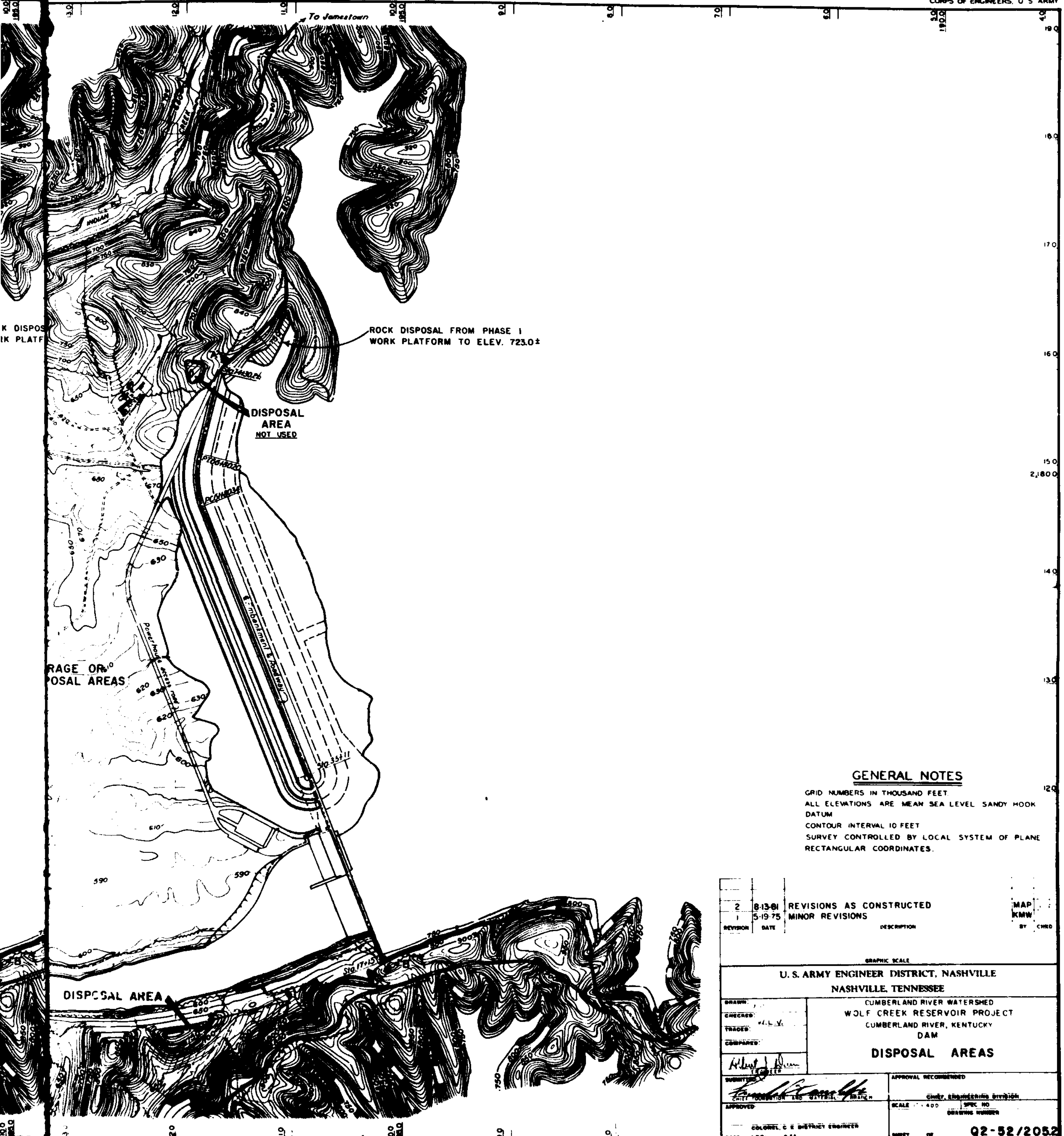
PLATE A-32

Q2-52/204



DISPOSAL AREA NOT USED
DISPOSAL AREA NOT USED
STORAGE OR DISPOSAL AREAS
DISPOSAL AREA
CUMBERLAND
CURRENT
BOYDS BAR
LITTLE
INDIAN
MILE + 439.0
MILE + 460.0
Powerhouse access road
Embankment & Roadway

CORPS OF ENGINEERS, U. S. ARMY



GENERAL NOTES

GRID NUMBERS IN THOUSAND FEET.
ALL ELEVATIONS ARE MEAN SEA LEVEL SANDY HOOK DATUM
CONTOUR INTERVAL 10 FEET
SURVEY CONTROLLED BY LOCAL SYSTEM OF PLANE RECTANGULAR COORDINATES.

REVISION	DATE	DESCRIPTION	BY	CHKD
2	8-13-81	REVISIONS AS CONSTRUCTED	MAP	
1	5-19-75	MINOR REVISIONS	KMW	

GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

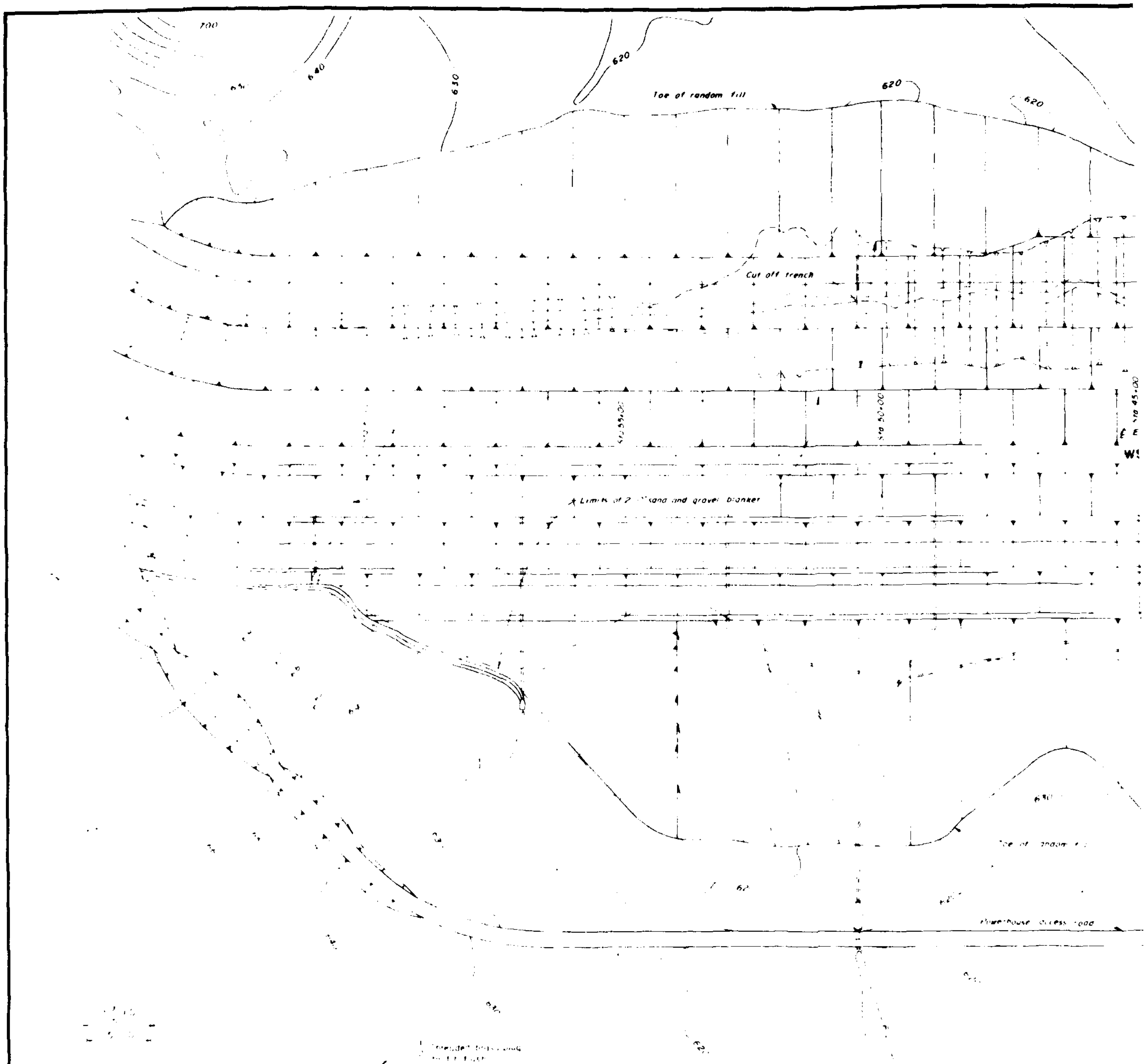
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

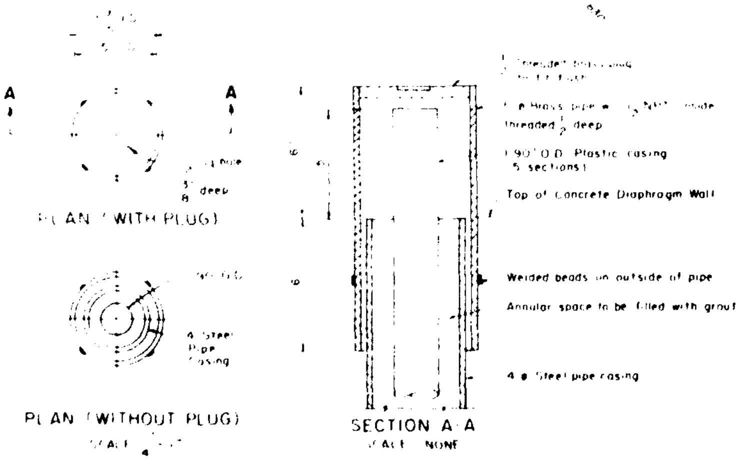
DISPOSAL AREAS

DRAWN:
CHECKED: W.L.V.
TRACED:
COMPARED:
ENGINEER
SUBMITTED:
CHIEF, FOUNDATION AND MATERIAL BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
DATE APRIL, 1975
SCALE 1" = 400
SPEC NO.
DRAWING NUMBER
SHEET OF
Q2-52/2052

RECORD DRAWING AS CONSTRUCTED DATED 7 MAY 1981

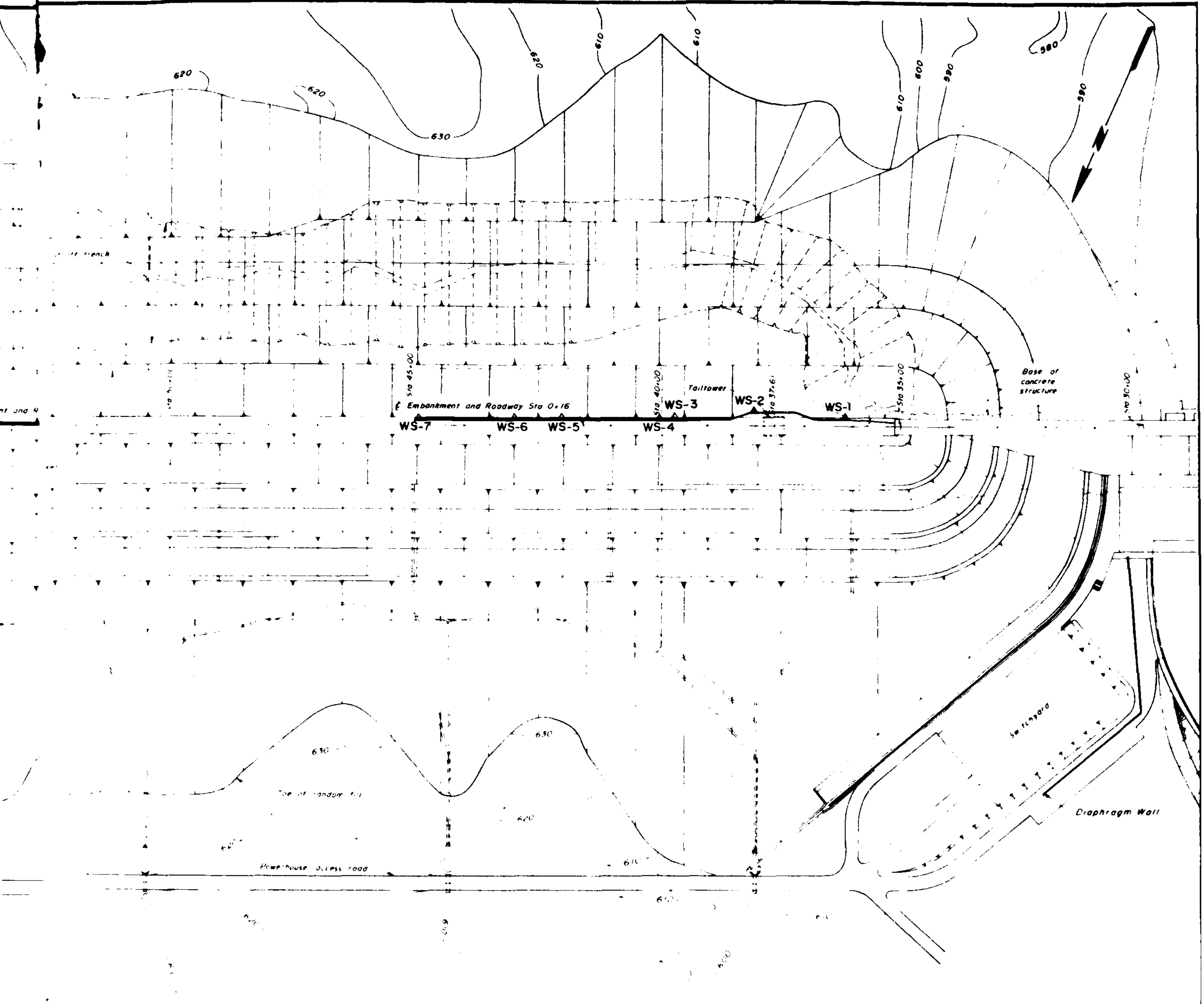
PLATE A-33





PROTECTIVE HOUSING DETAILS

INCLINOMETER LOCATION			
INSTALLATION	COORDINATES		ESTIMATED DEPTH OF INSTRUMENT
	"L" STATION	"A" & "B" STATION	
WS-1	36+14	0+00AB	278.0 FT
WS-2	38+01	0+145A	213.0 FT
WS-3	39+70	0+00AB	213.0 FT
WS-4	40+015	0+00AB	213.0 FT
WS-5	41+995	0+00AB	213.0 FT
WS-6	42+985	0+00AB	213.0 FT
WS-7	44+92	0+00AB	213.0 FT



PLAN

...INOMETER LOCATION		
...OORDINATES		ESTIMATED DEPTH
...TATION	"A" B "B" STATION	OF INSTRUMENT
6+ 4	0+00AB	278.0 FT
[illegible]	0+145A	213.0 FT
9+70	0+00AB	213.0 FT
...+01.5	0+00AB	213.0 FT
...+99.5	0+00AB	213.0 FT
...+98.4	0+00AB	213.0 FT
...+92	0+00AB	213.0 FT

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

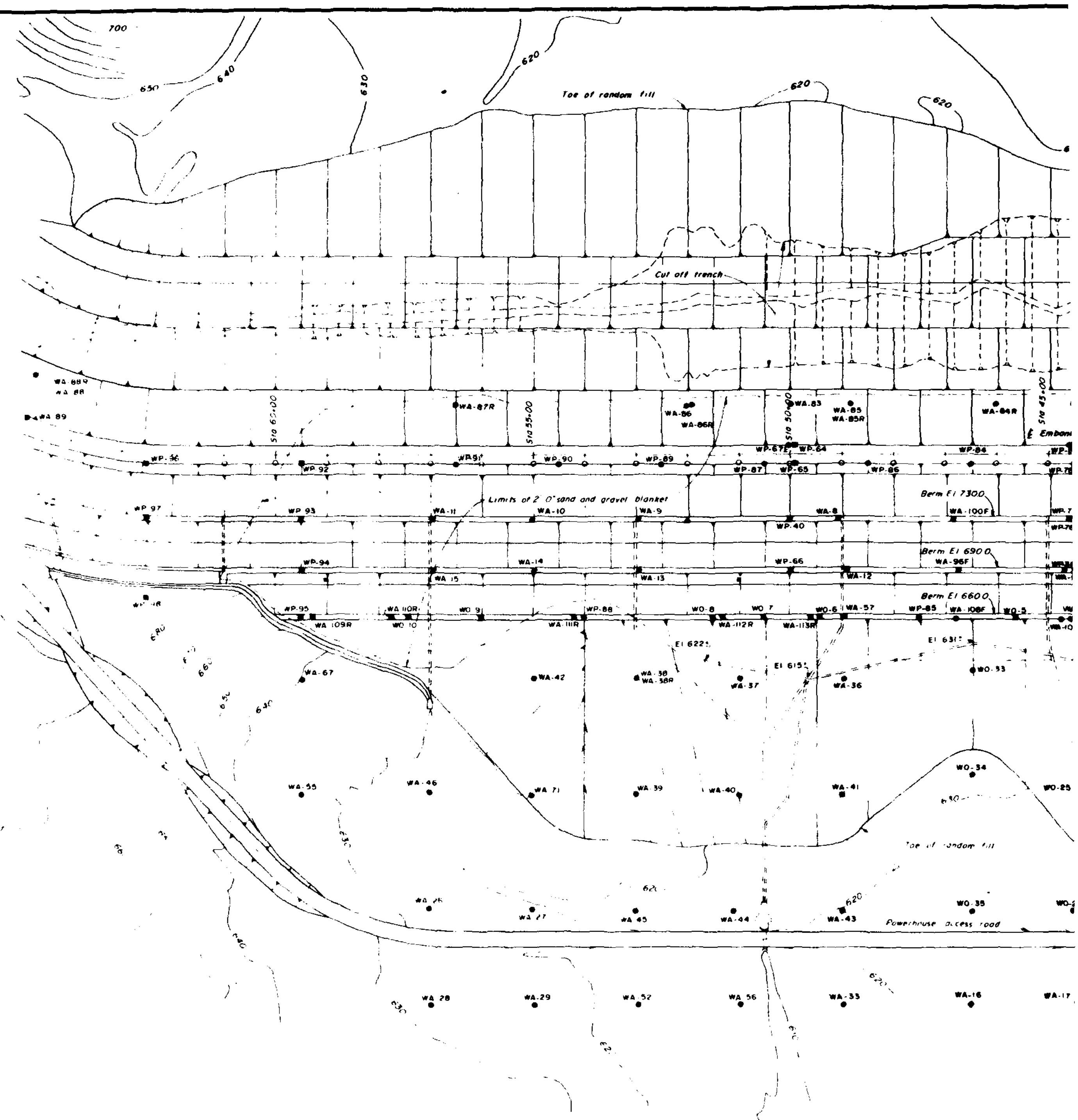
DRAWN: ...
CHECKED: AJD
TRACED:
COMPARED:

...UMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
...UMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION
PLAN

SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
DATE: APRIL 1975
SCALE: ...100
SPEC. NO.
DRAWING NUMBER
SHEET OF
02-52/206

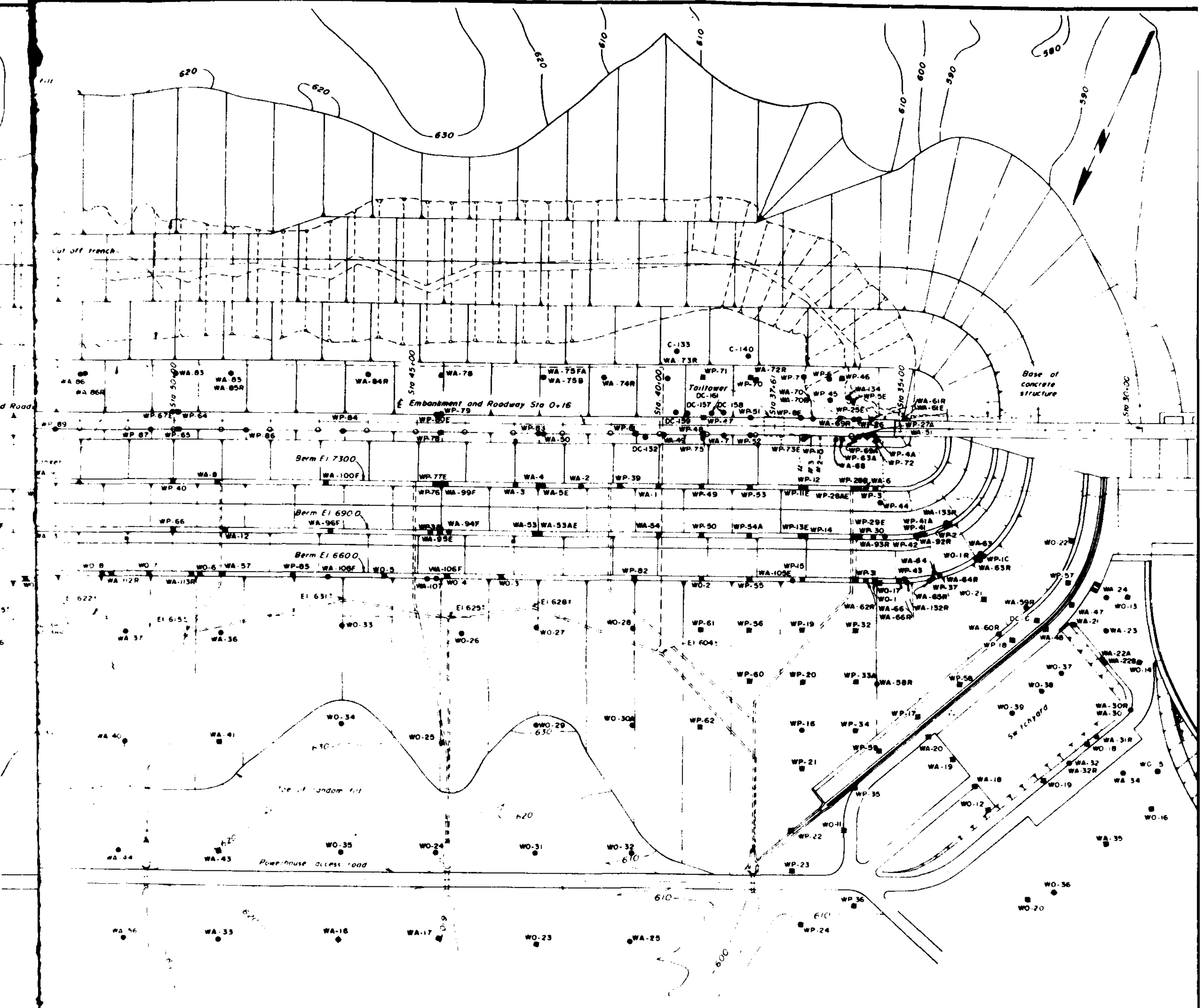
RECORD DRAWING AS CONSTRUCTED DATE

PLATE A-34



700
650
640
630
620
Toe of random fill
Cut off trench
Sta 60+00
Sta 55+00
Sta 50+00
Sta 45+00
Limits of 2.0' sand and gravel blanket
Berm El 7300
Berm El 6900
Berm El 6600
El 6225
El 6155
Toe of random fill
Powerhouse access road

PLAN



PLAN

LEGEND
- *WA-33E - Embankment Piezometer*
- *WA-33F - Filter Piezometer*
- *WA-33 - Top of Rock Piezometer*
- *WA-33R - Bedrock Piezometer*
- ● *Existing Piezometer*
- o *Surface Movement Monument*

REVISION	DATE	DESCRIPTION	BY	CHKD.

100' 0 100' 200'

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN: T C
CHECKED: A D

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

EXISTING INSTRUMENTATION
AND MONUMENTATION
PLAN

CHIEF, FOUNDATIONS AND MATERIALS BRANCH

CHIEF, ENGINEERING DIVISION

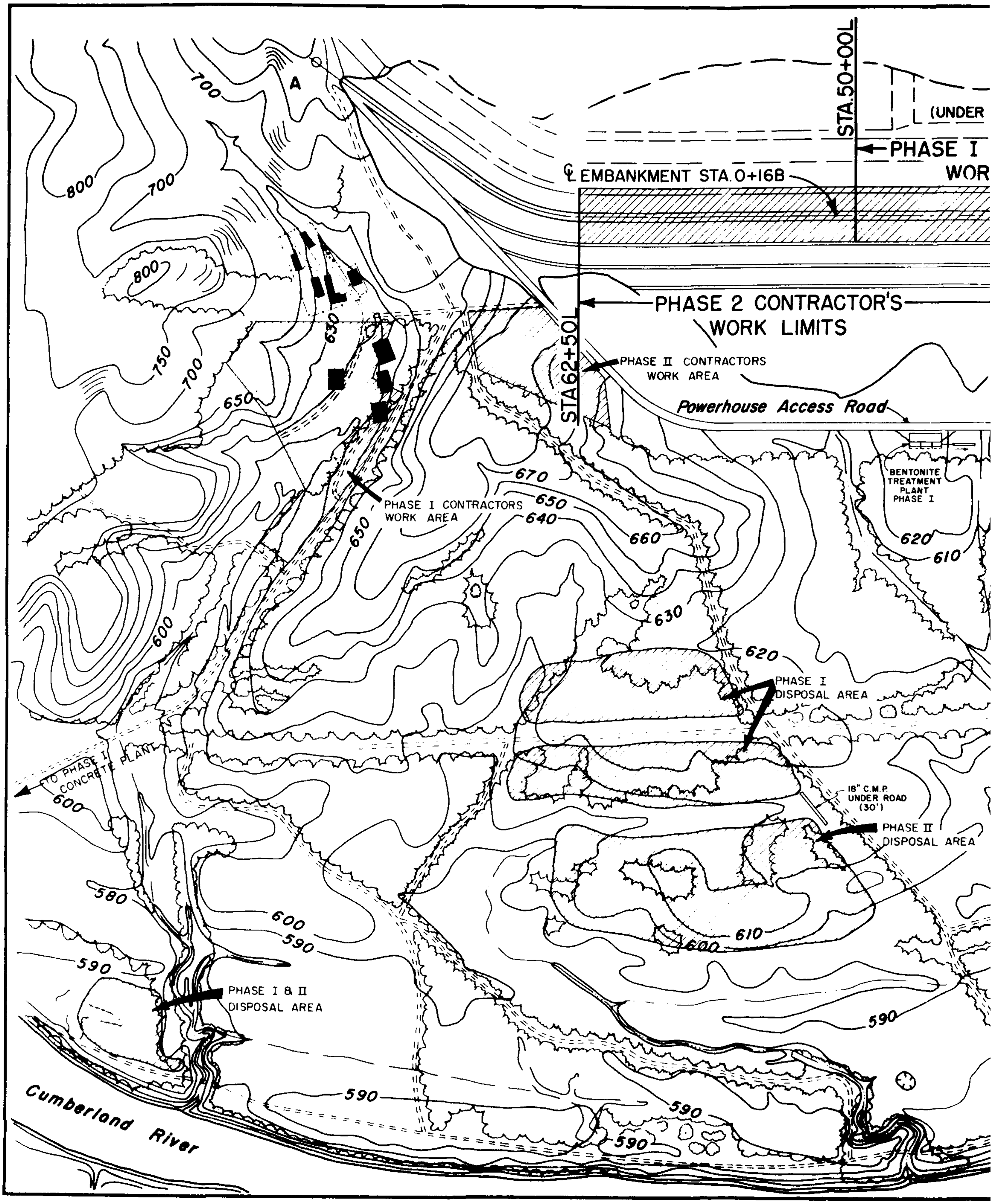
COLONEL, C.E. DISTRICT ENGINEER

SCALE: 1" = 100'

DATE: APRIL 1975

92-52/207

PLATE A-35


STA.50+00L
(UNDER
PHASE I
WOR
℄ EMBANKMENT STA.0+16B
PHASE 2 CONTRACTOR'S
WORK LIMITS
STA62+50L
PHASE II CONTRACTORS
WORK AREA
Powerhouse Access Road
BENTONITE
TREATMENT
PLANT
PHASE I
PHASE I CONTRACTORS
WORK AREA
PHASE I
DISPOSAL AREA
TO PHASE I
CONCRETE PLANT
18" C.M.P.
UNDER ROAD
(30')
PHASE II
DISPOSAL AREA
PHASE I & II
DISPOSAL AREA
Cumberland River
A
800
700
750
650
630
600
670
640
660
620
610
580
590

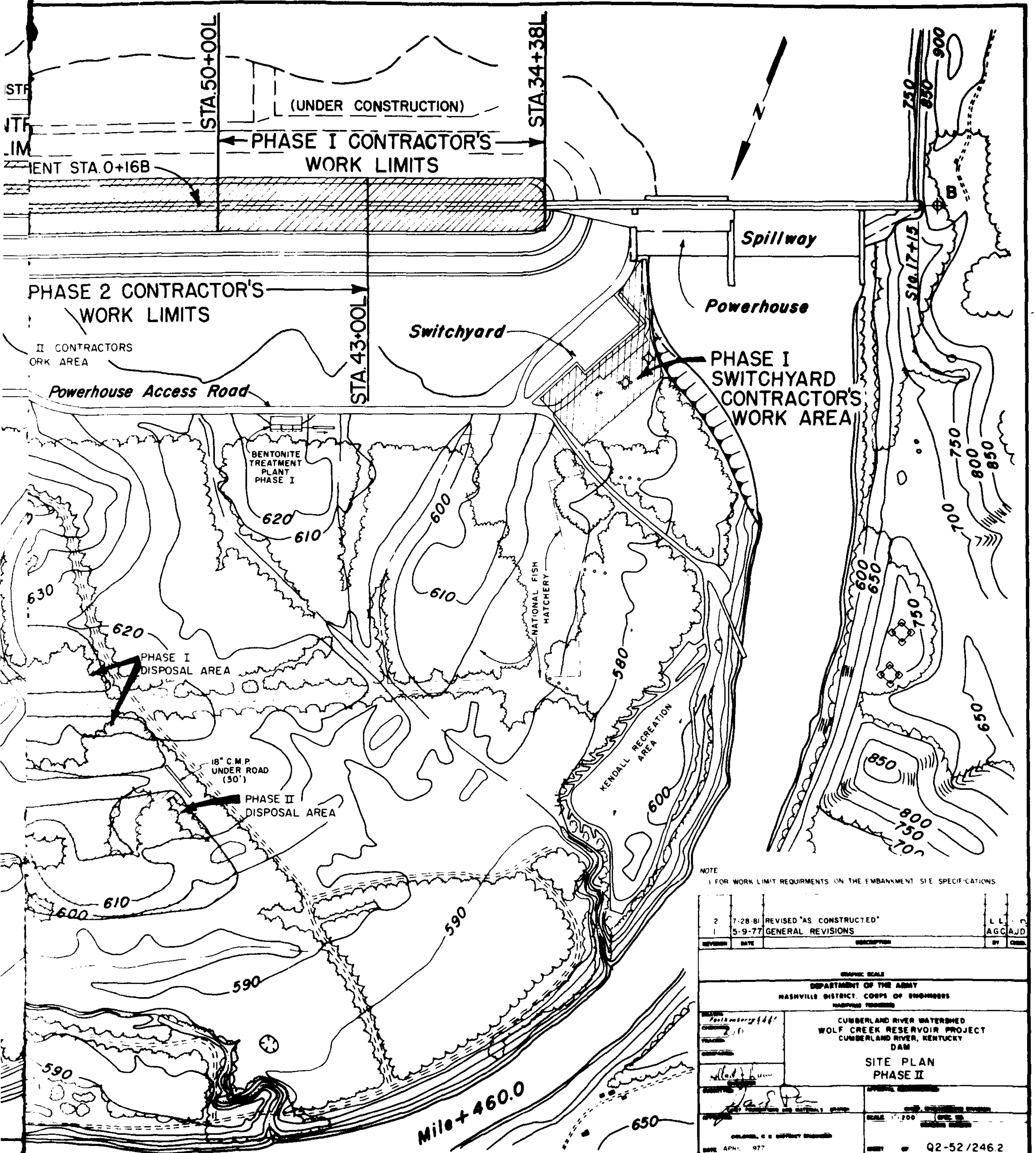
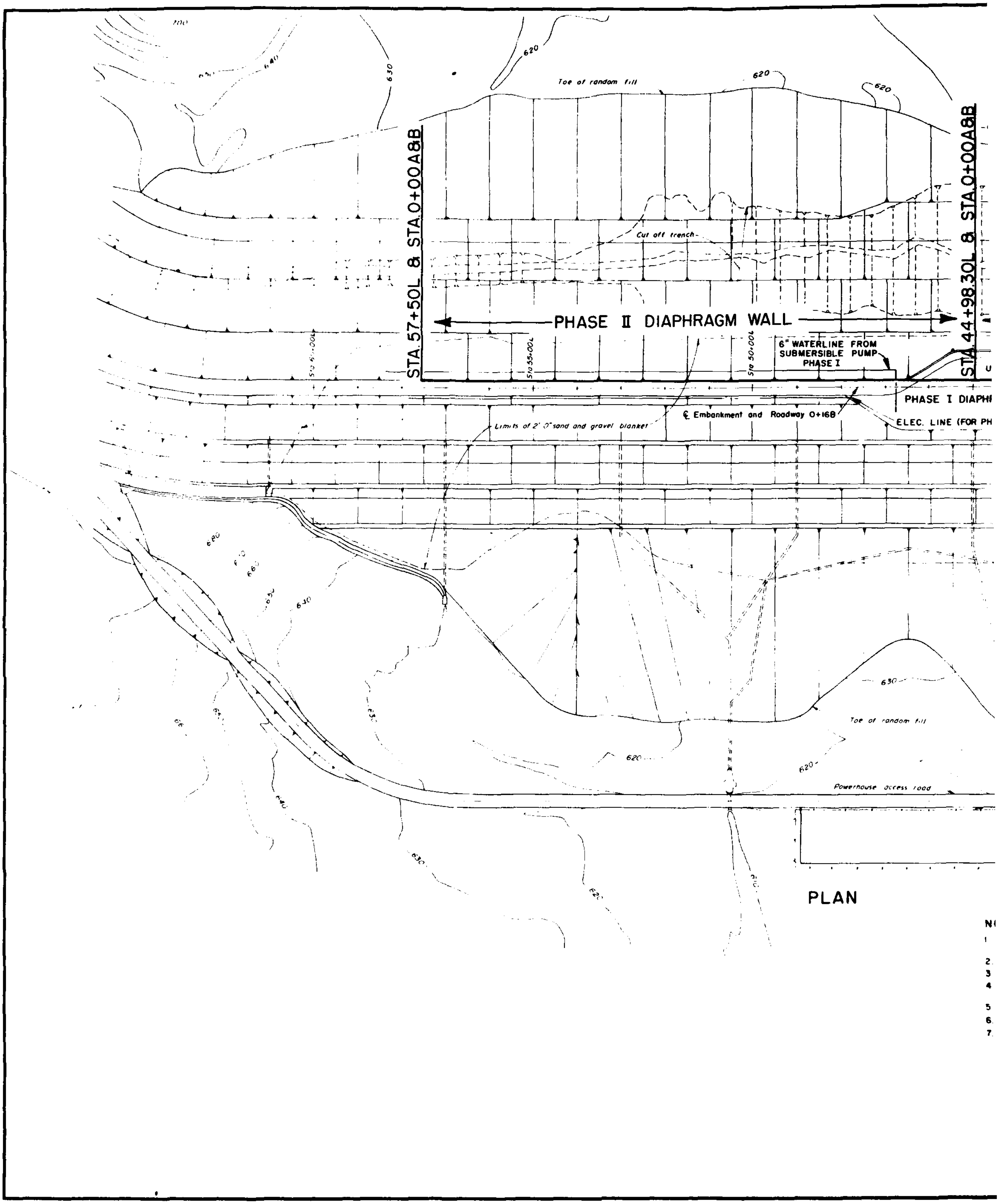
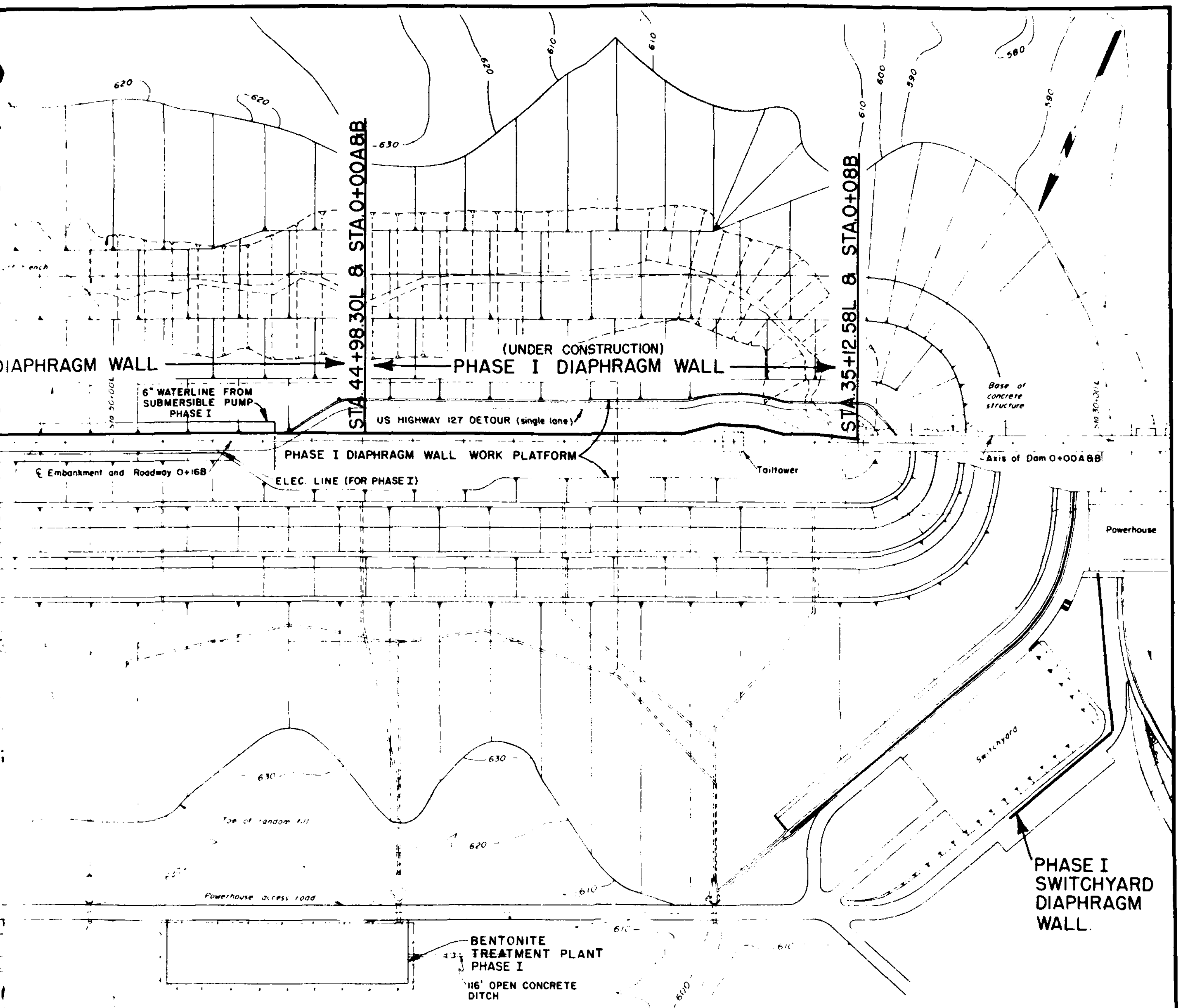

STA.50+00L
STA.34+38L
(UNDER CONSTRUCTION)
PHASE I CONTRACTOR'S WORK LIMITS
Spillway
Powerhouse
PHASE 2 CONTRACTOR'S WORK LIMITS
STA.43+00L
Switchyard
PHASE I SWITCHYARD CONTRACTOR'S WORK AREA
Powerhouse Access Road
STA.17+15
BENTONITE TREATMENT PLANT PHASE I
NATIONAL FISH HATCHERY
KENDALL RECREATION AREA
PHASE I DISPOSAL AREA
18" C.M.P. UNDER ROAD (30')
PHASE II DISPOSAL AREA
Mile+460.0
NOTE
1 FOR WORK LIMIT REQUIREMENTS ON THE EMBANKMENT SEE SPECIFICATIONS
2 7-28-81 REVISED "AS CONSTRUCTED"
1 5-9-77 GENERAL REVISIONS
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
SITE PLAN
PHASE II
Q2-52/246.2

PLATE A-36


STA. 57+50L & STA. 0+00A&B
STA. 44+98.30L & STA. 0+00A&B
PHASE II DIAPHRAGM WALL
6" WATERLINE FROM SUBMERSIBLE PUMP PHASE I
PHASE I DIAPH
ELEC. LINE (FOR PH
℄ Embankment and Roadway 0+168
Limits of 2' 0" sand and gravel blanket
Cut off trench
Toe of random fill
Powerhouse access road
PLAN



PLAN

NOTES.

1. FOR PLAN AND PROFILE ALONG DIAPHRAGM WALL SEE DWGS. Q2-52/248 TO 250.
2. FOR SECTIONS AT DIAPHRAGM WALL SEE DWGS. Q2-52/251 & 252.
3. FOR PLAN OF EXPLORATIONS SEE DWGS. Q2-52/260 & 261.
4. FOR GEOLOGIC SECTIONS ALONG DIAPHRAGM WALL ALIGNMENT SEE DWGS. Q2-52/262 THROUGH 267.
5. FOR PLAN OF EXISTING INSTRUMENTATION SEE DWG. Q2-52/272.
6. ALL ELEV. ARE MEAN SEA LEVEL, SANDY HOOK DATUM.
7. FOR SITE RESTORATION, SEE SPECIFICATIONS.

REVISION	DATE	DESCRIPTION	BY	CHKD
2	7-29-81	REVISED "AS CONSTRUCTED"	L.L.	
1	5-9-77	GENERAL REVISIONS	AGC	AJD

100 0 100 200
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

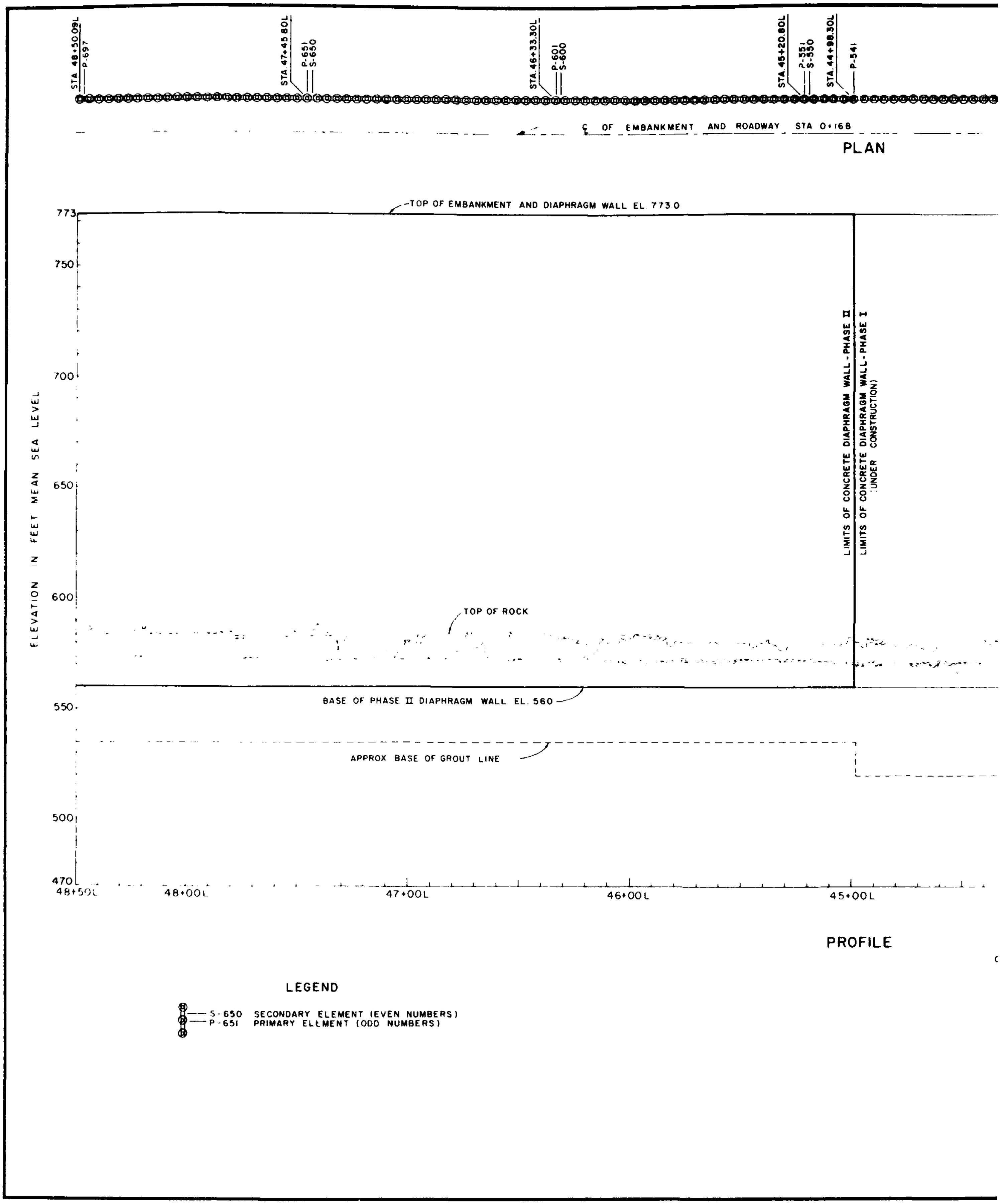
DRAWN: CHAPMAN & B.F.
CHECKED:
TRACED:
COMPARED:
ENGINEER

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
GENERAL PLAN
CONCRETE DIAPHRAGM WALL
PHASE II

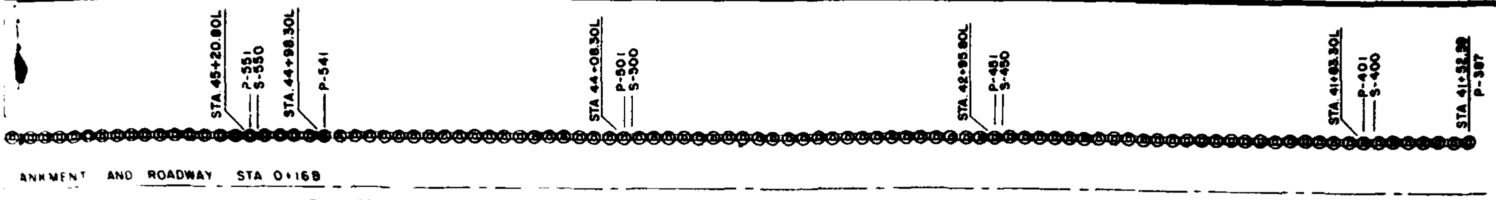
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
SCALE: 1" = 100'
SPEC NO.
DRAWING NUMBER
DATE APRIL 1977
SHEET OF
Q2-52/247.2

RECORD DRAWING AS CONSTRUCTED DATED 7 MAY 1981

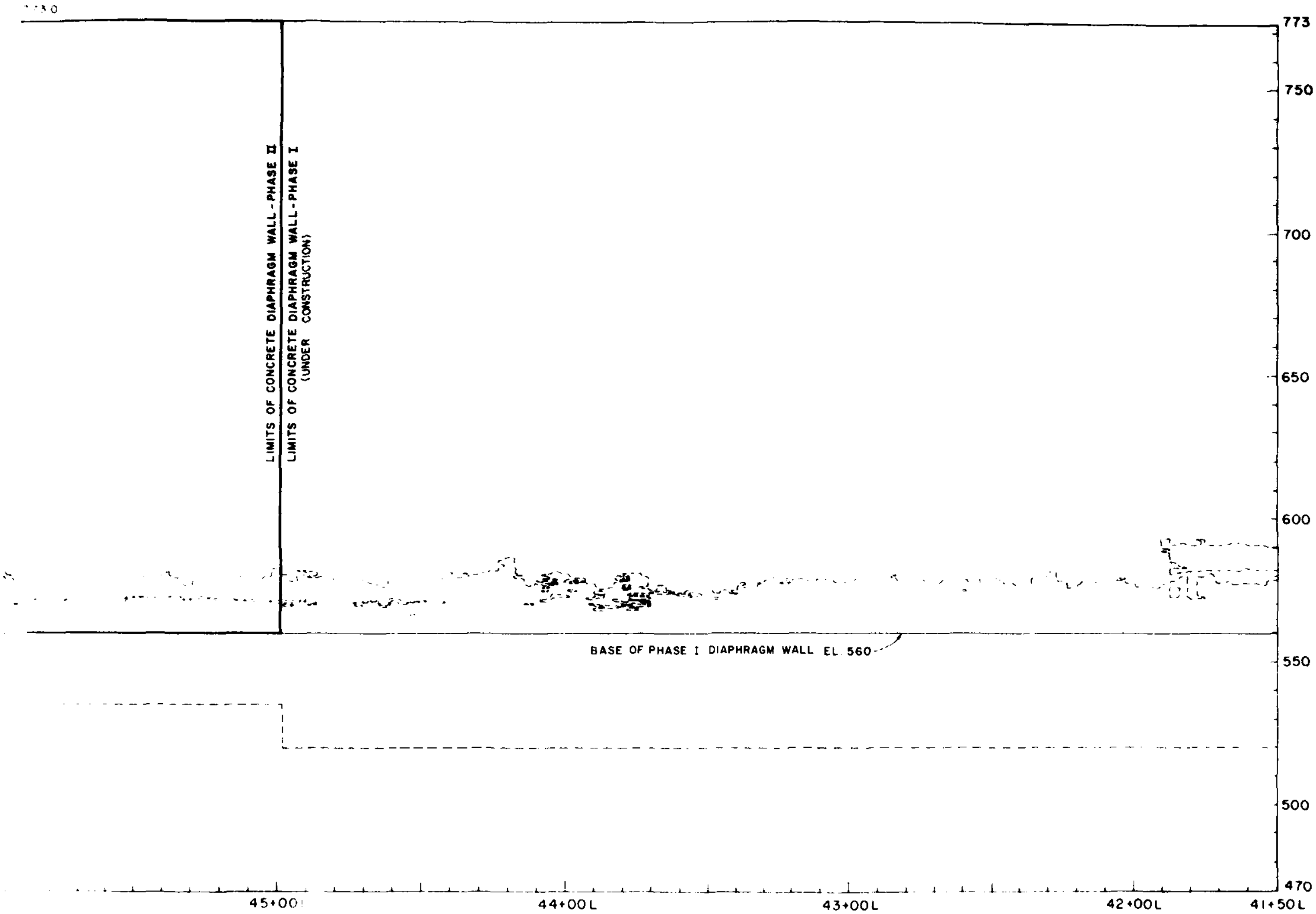
PLATE A-37



STA 48+50.09L
P-697
STA 47+45.80L
P-651
S-650
STA 46+33.30L
P-601
S-600
STA 45+20.80L
P-551
S-550
STA 44+98.30L
P-541
℄ OF EMBANKMENT AND ROADWAY STA 0+168
PLAN
TOP OF EMBANKMENT AND DIAPHRAGM WALL EL 773.0
ELEVATION IN FEET MEAN SEA LEVEL
773
750
700
650
600
550
500
470
LIMITS OF CONCRETE DIAPHRAGM WALL-PHASE II
LIMITS OF CONCRETE DIAPHRAGM WALL-PHASE I (UNDER CONSTRUCTION)
TOP OF ROCK
BASE OF PHASE II DIAPHRAGM WALL EL. 560
APPROX BASE OF GROUT LINE
48+50L
48+00L
47+00L
46+00L
45+00L
PROFILE
LEGEND
S-650 SECONDARY ELEMENT (EVEN NUMBERS)
P-651 PRIMARY ELEMENT (ODD NUMBERS)



PLAN



PROFILE

GENERAL NOTES

1 FOR GEOLOGIC SECTIONS ALONG DIAPHRAGM WALL ALIGNMENT SEE DWG Q2-52/262 THROUGH Q2-52/267

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-9-77	GENERAL REVISIONS	AGC	AJD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN AGC & BF
CHECKED

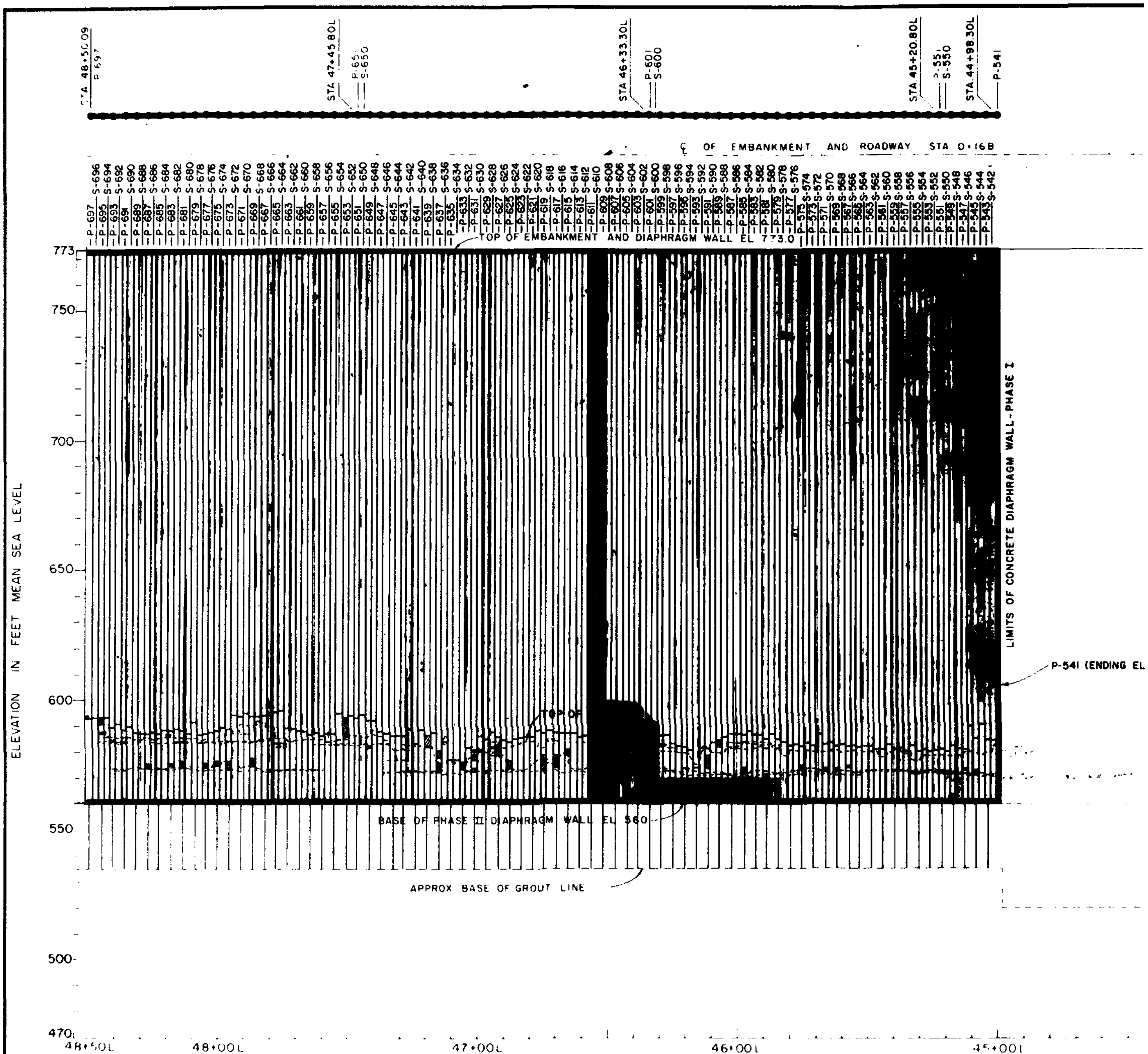
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
CONCRETE DIAPHRAGM WALL
PLAN AND PROFILE
STA 41+50L TO STA 48+50L

SUBMITTED
APPROVED
COLONEL, C E DISTRICT ENGINEER
DATE APRIL 1977

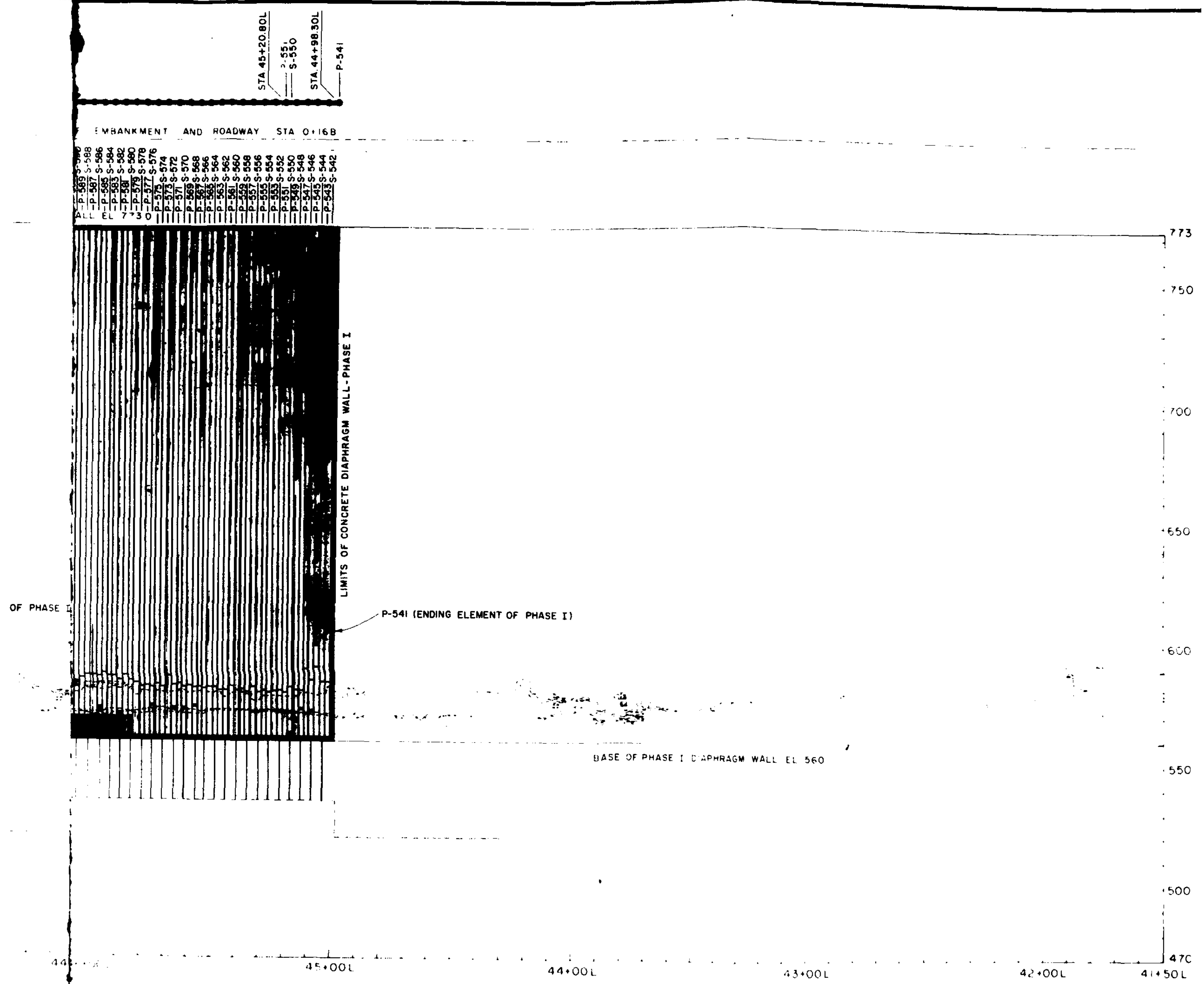
SCALE 1"=20'

Q2-52/248.1

PLATE A-38


STA 48+50.09
STA 47+45.80L
STA 46+33.30L
P-601
S-600
STA 45+20.80L
S-550
STA 44+98.30L
P-541
℄ OF EMBANKMENT AND ROADWAY STA 0+16B
TOP OF EMBANKMENT AND DIAPHRAGM WALL EL 773.0
ELEVATION IN FEET MEAN SEA LEVEL
773
750
700
650
600
550
500
470
LIMITS OF CONCRETE DIAPHRAGM WALL-PHASE I
P-541 (ENDING EL
BASE OF PHASE II DIAPHRAGM WALL EL 560
APPROX BASE OF GROUT LINE
48+00L
47+00L
46+00L

PROFILE



PROFILE

LEGEND

TOP OF ROCK

CAVITY ENCOUNTERED DURING EXCAVATION

COMPLETED ELEMENT

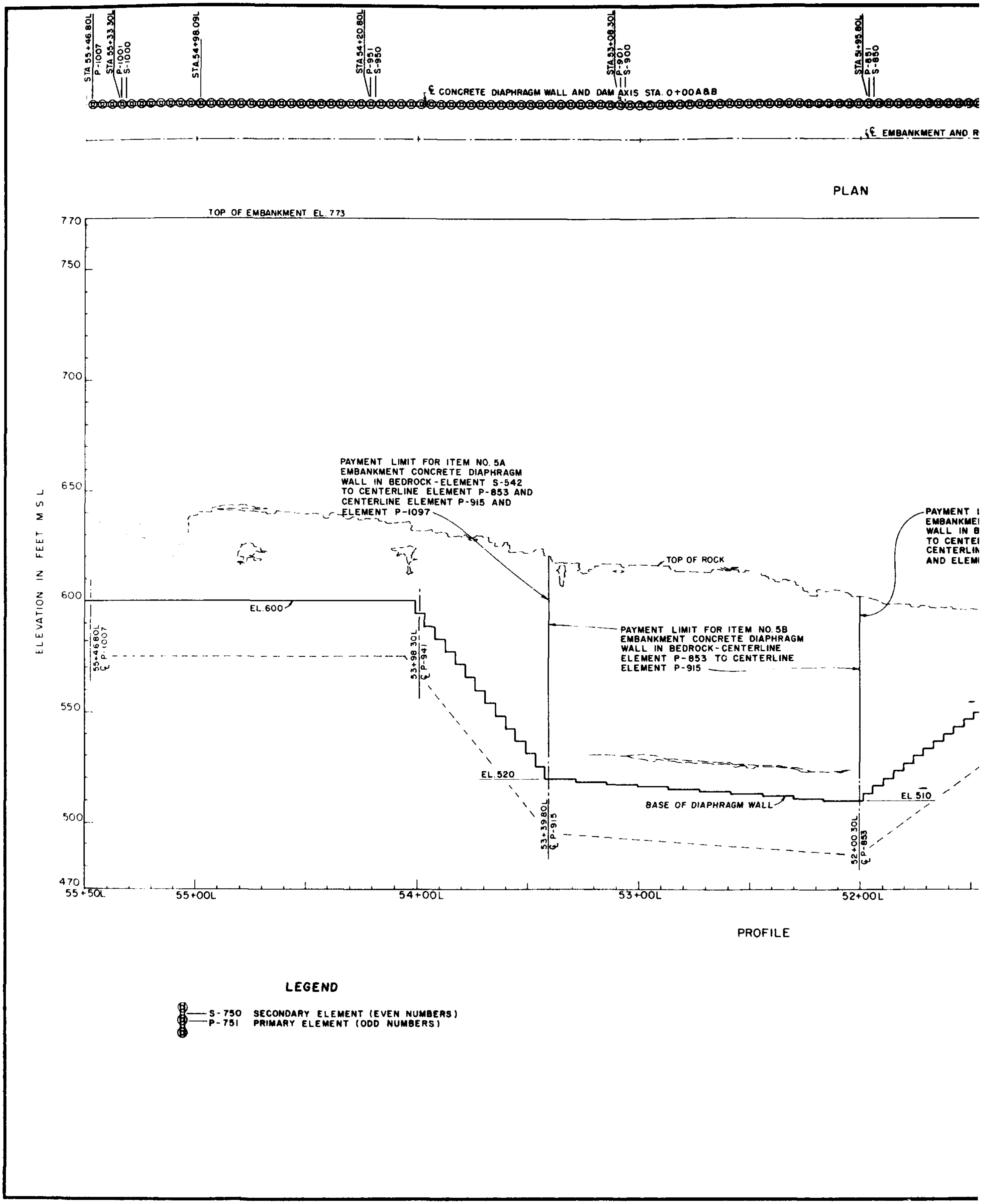
REVISION	DATE	DESCRIPTION

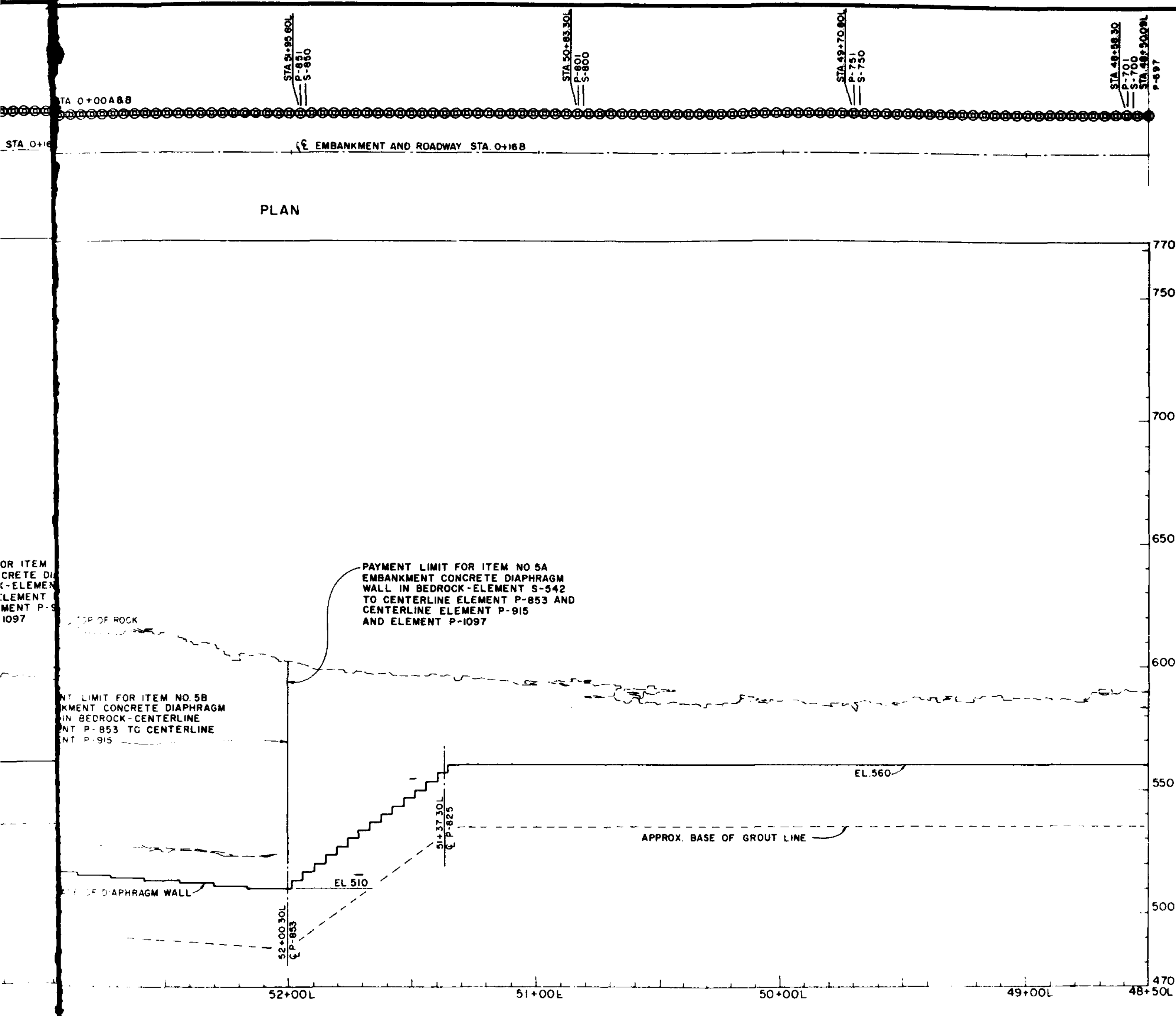
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
PHASE II CONCRETE DIAPHRAGM W
SOLUTION FEATURES
STA 41+50L TO STA 48+50L

DRAWN
CHECKED
TRACED
COMPARED
SUBMITTED
APPROVED
APPROVAL RECOMMENDED
SCALE 1"=20'
DRAWING NUMBER
SHEET OF
Q2-52/2

PLATE A-39


STA 55+46.80L
P-1007
STA 55+33.30L
P-1001
S-1000
STA 54+98.09L
STA 54+20.80L
P-951
S-950
STA 53+08.30L
P-901
S-900
STA 51+95.80L
P-851
S-850
℄ CONCRETE DIAPHRAGM WALL AND DAM AXIS STA. 0+00A&B
℄ EMBANKMENT AND R
PLAN
TOP OF EMBANKMENT EL. 773
ELEVATION IN FEET M S L
770
750
700
650
600
550
500
470
PAYMENT LIMIT FOR ITEM NO. 5A EMBANKMENT CONCRETE DIAPHRAGM WALL IN BEDROCK-ELEMENT S-542 TO CENTERLINE ELEMENT P-853 AND CENTERLINE ELEMENT P-915 AND ELEMENT P-1097
TOP OF ROCK
EL. 600
55+46.80L ℄ P-1007
53+98.30L ℄ P-941
PAYMENT LIMIT FOR ITEM NO. 5B EMBANKMENT CONCRETE DIAPHRAGM WALL IN BEDROCK-CENTERLINE ELEMENT P-853 TO CENTERLINE ELEMENT P-915
EL. 520
BASE OF DIAPHRAGM WALL
EL 510
53+39.80L ℄ P-915
52+00.30L ℄ P-853
55+50L
55+00L
54+00L
53+00L
52+00L
PROFILE
LEGEND
S-750 SECONDARY ELEMENT (EVEN NUMBERS)
P-751 PRIMARY ELEMENT (ODD NUMBERS)



PROFILE

NOTE
1 FOR GENERAL NOTES SEE DWG Q2-52/248

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE 20' 0 20' 40

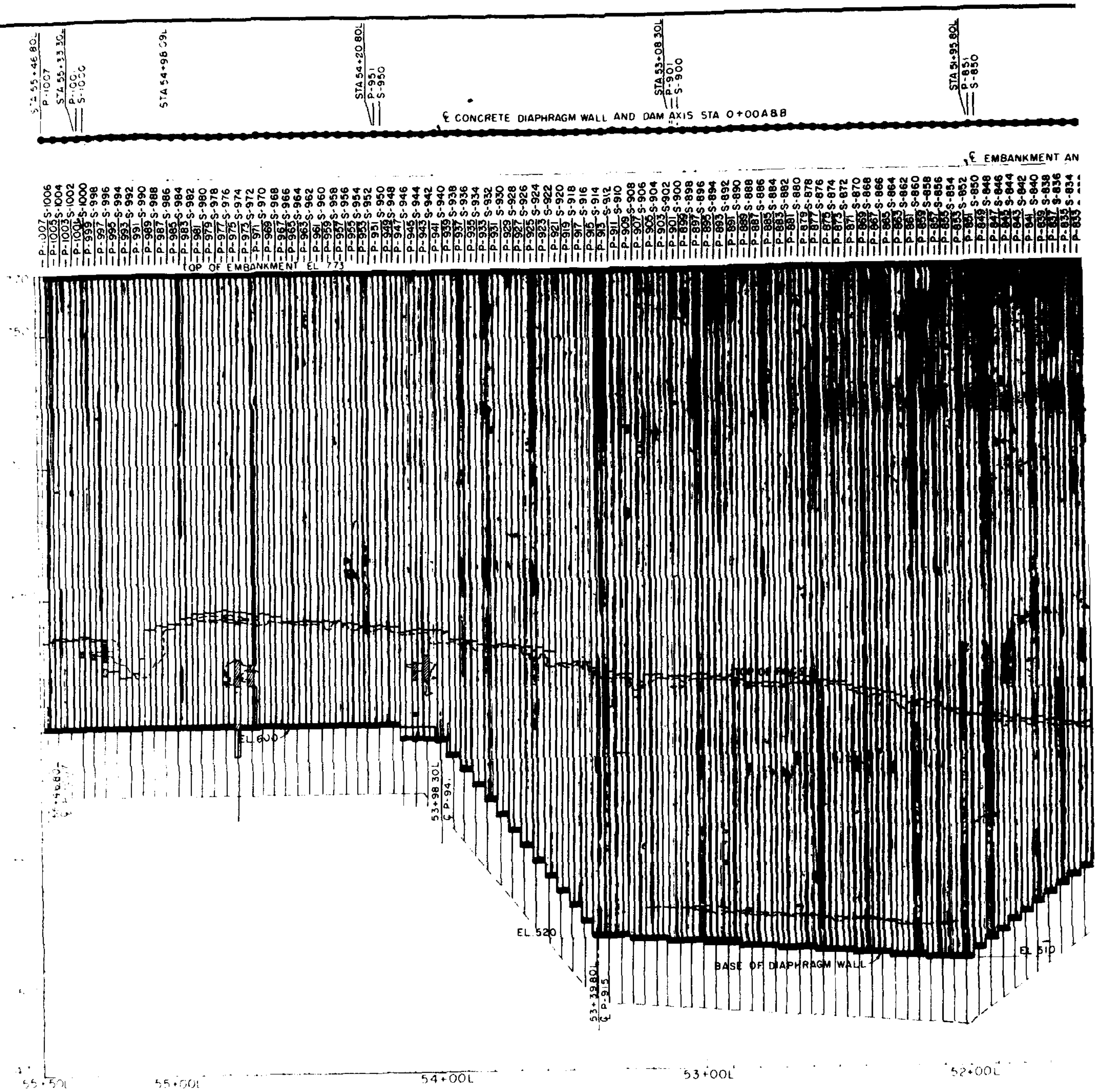
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN: AGC & BF
CHECKED: AJO

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
CONCRETE DIAPHRAGM WALL
PLAN AND PROFILE
STA. 48+50L TO STA. 55+50L

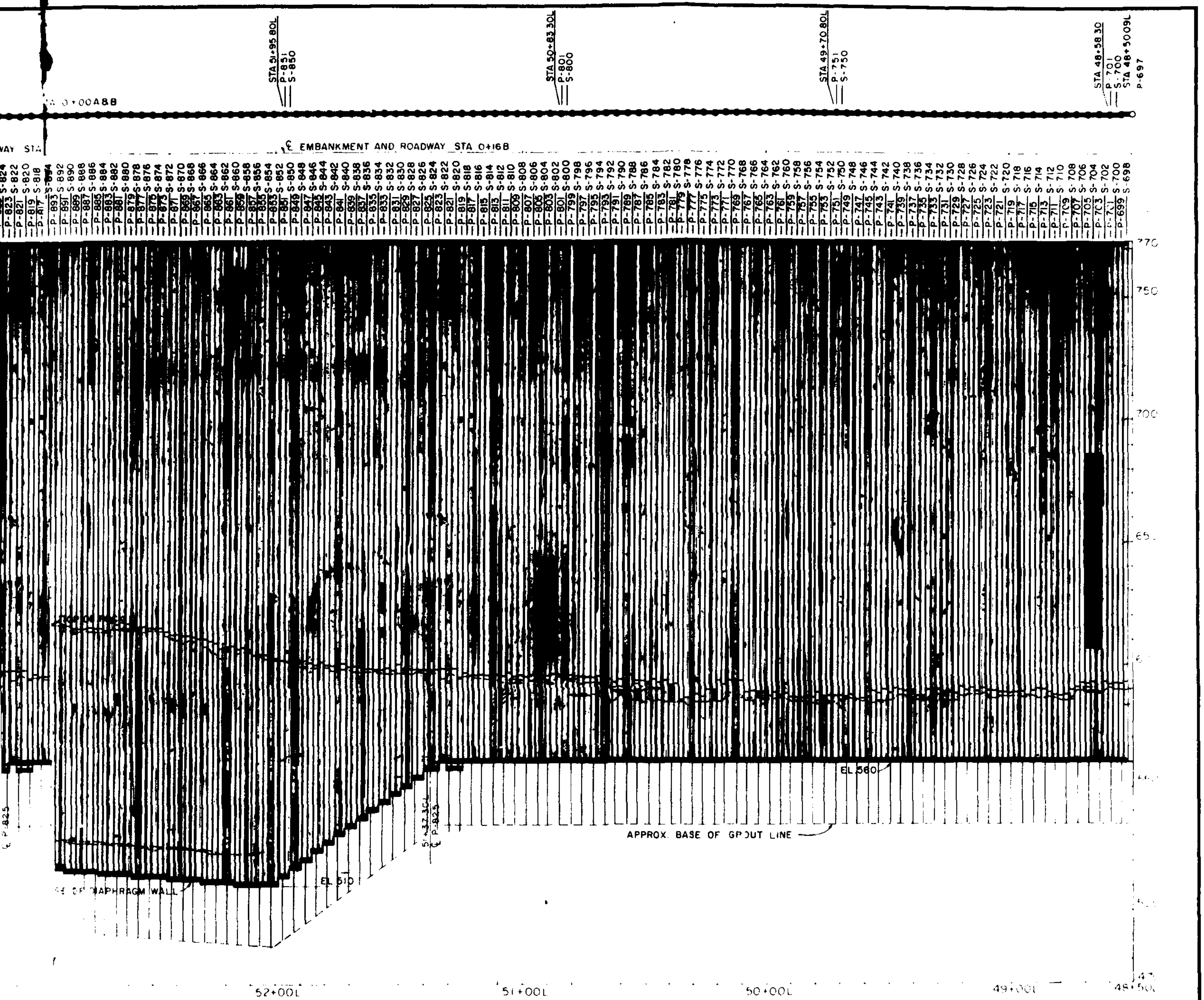
SCALE: 1" = 20'
DATE: APRIL 1977
Q2-52/249

PLATE A-40



STA 54+20.80L
P-951
S-950
STA 53+08.30L
P-901
S-900
STA 51+95.80L
P-851
S-850
℄ CONCRETE DIAPHRAGM WALL AND DAM AXIS STA 0+00A88
℄ EMBANKMENT AN
TOP OF EMBANKMENT EL 773
EL 600
EL 520
EL 510
BASE OF DIAPHRAGM WALL
53+98.30L
53+39.80L
55+50L
55+00L
54+00L
53+00L
52+00L

PROFILE



PROFILE

LEGEND

TOP OF ROCK

CAVITY ENCOUNTERED DURING EXCAVATION

COMPLETED ELEMENT

REVISION	DATE	DESCRIPTION	BY	APP

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY

DAM

PHASE II CONCRETE DIAPHRAGM WALL

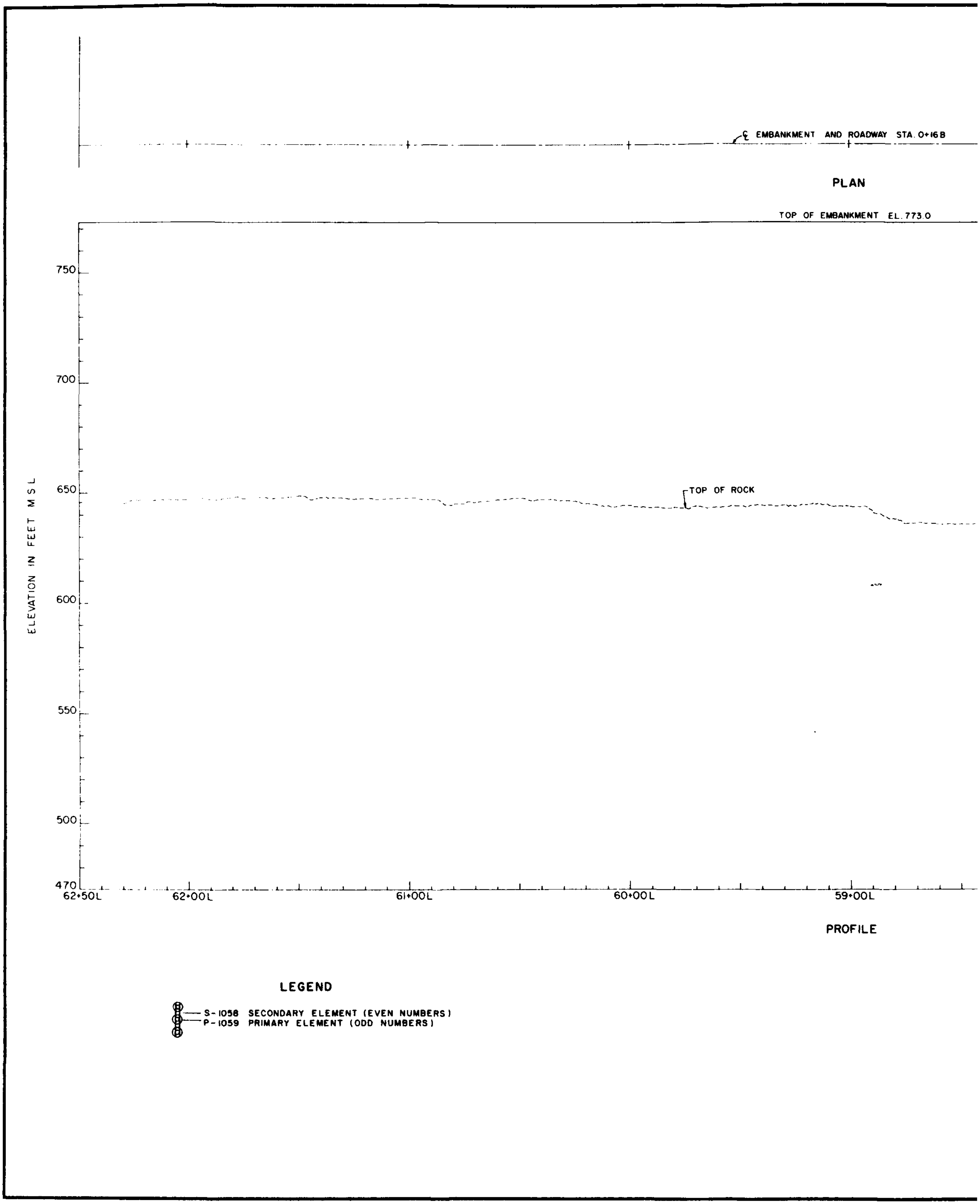
SOLUTION FEATURES

STA 48+50L TO STA 55+50L

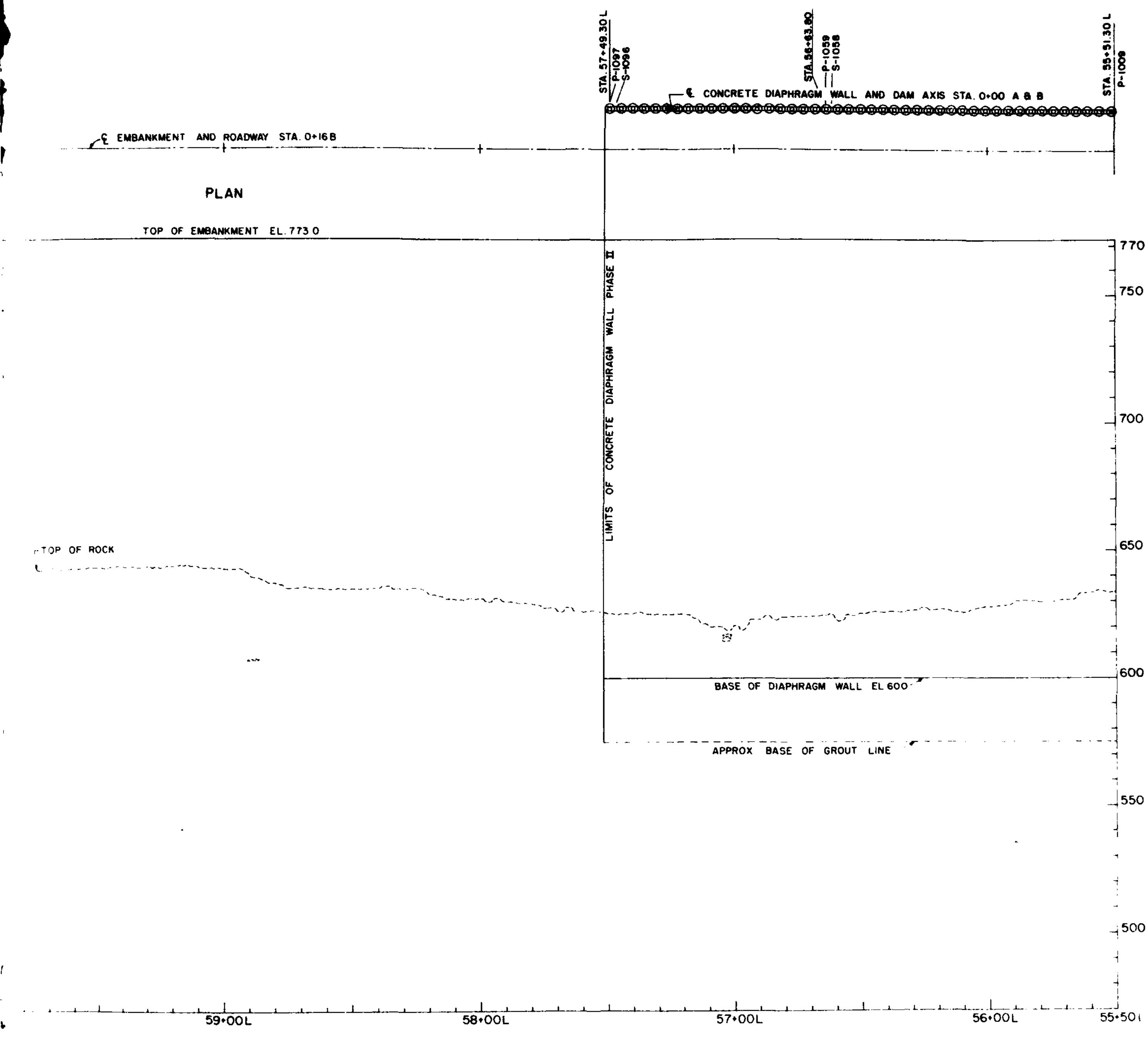
DRAWN L L
CHECKED
TRACED
COMPARED
ENGINEER
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
DATE
SCALE
SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/249A

RECORD DRAWING AS CONSTRUCTED DATED

PLATE A-41



℄ EMBANKMENT AND ROADWAY STA. 0+16B
PLAN
TOP OF EMBANKMENT EL. 773.0
750
700
650
600
550
500
470
ELEVATION IN FEET MSL
TOP OF ROCK
62+50L
62+00L
61+00L
60+00L
59+00L
PROFILE
LEGEND
S-1058 SECONDARY ELEMENT (EVEN NUMBERS)
P-1059 PRIMARY ELEMENT (ODD NUMBERS)



PROFILE

NOTE:
1. FOR GENERAL NOTES SEE DWG Q2-52/248

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE 20 0 20 40

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

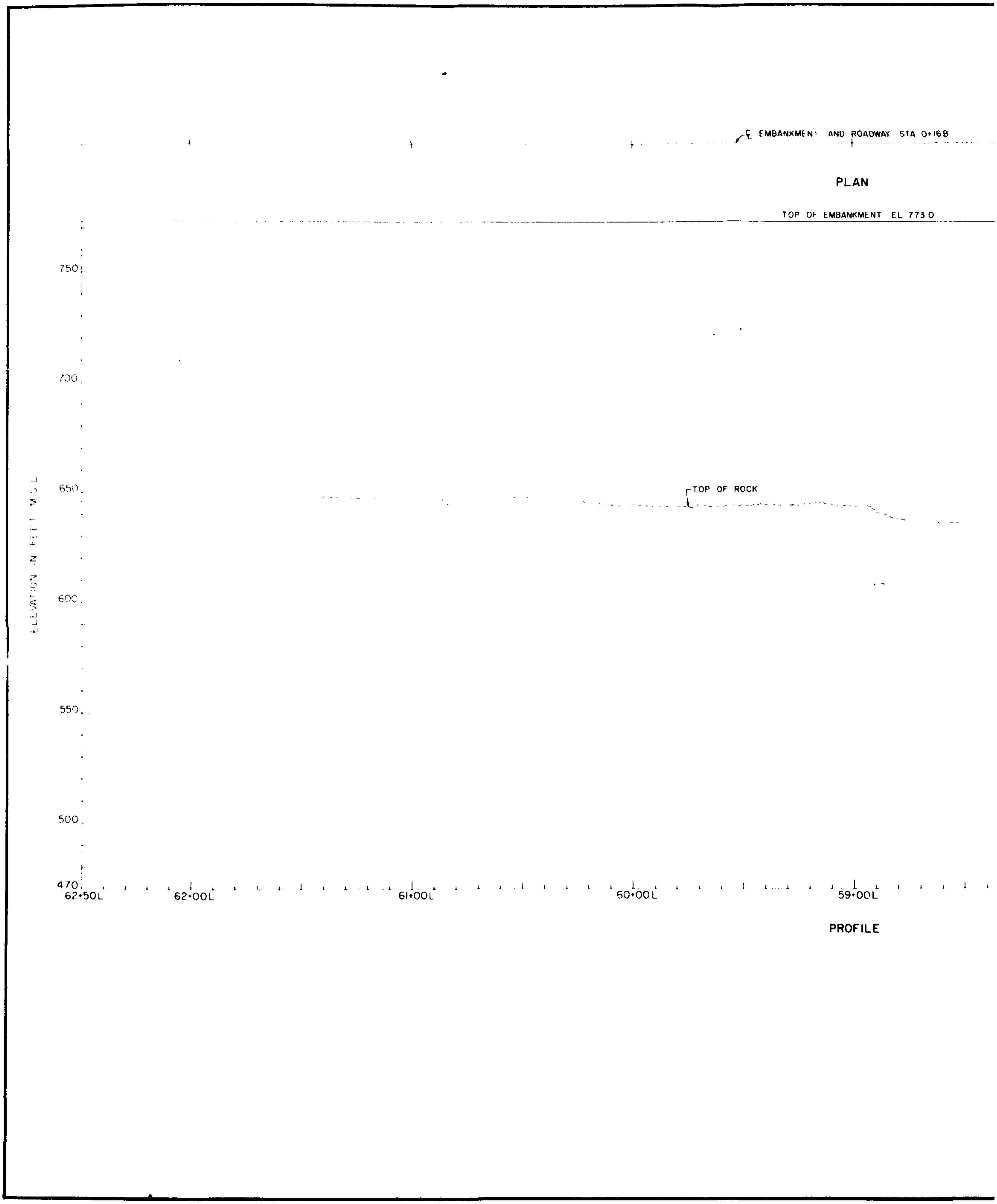
DRAWN AGC
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
CONCRETE DIAPHRAGM WALL
PLAN AND PROFILE
STA 55+50L TO STA 62+50L

ENGINEER
SUBMITTED
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E DISTRICT ENGINEER
SCALE 1" = 20'
SPEC NO
DRAWING NUMBER
DATE APRIL 1977
SHEET OF
Q2-52/250

PLATE A-42

7 May 1981


℄ EMBANKMENT AND ROADWAY STA 0+168
PLAN
TOP OF EMBANKMENT EL 773.0
750
700
650
600
550
500
470
ELEVATION IN FEET M.S.L.
TOP OF ROCK
62+50L
62+00L
61+00L
60+00L
59+00L
PROFILE

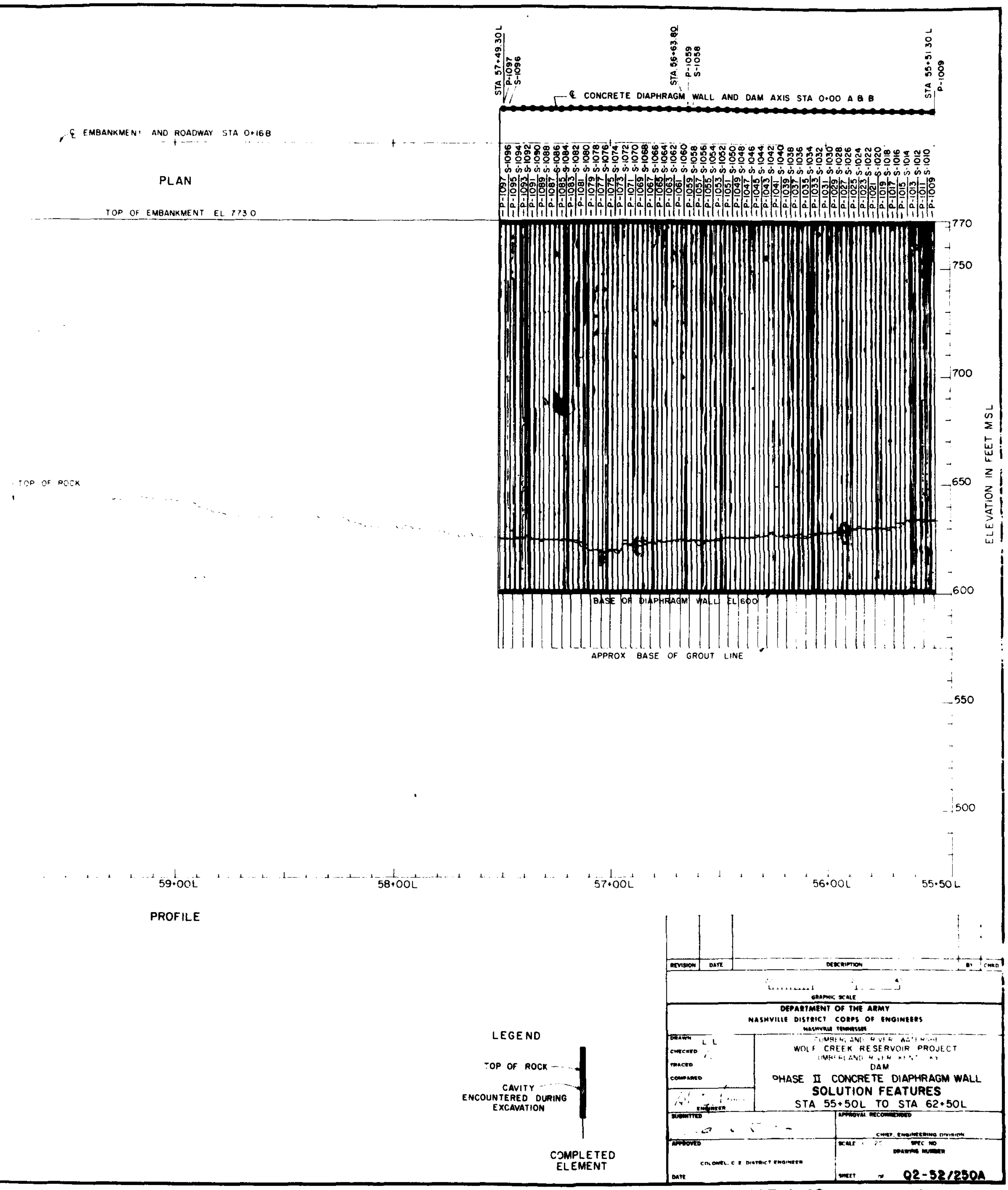
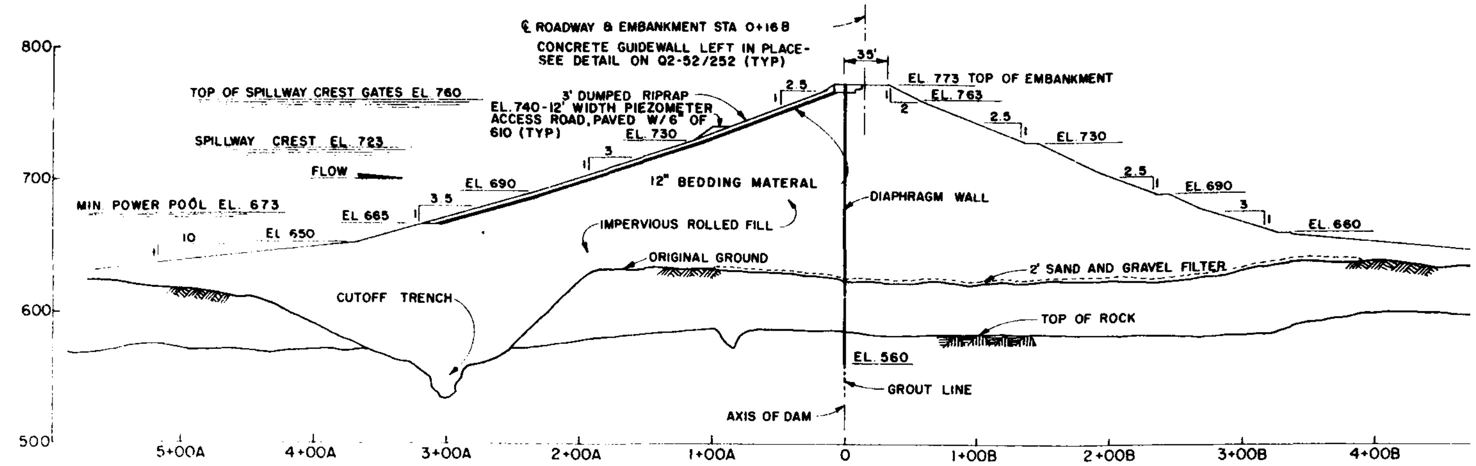
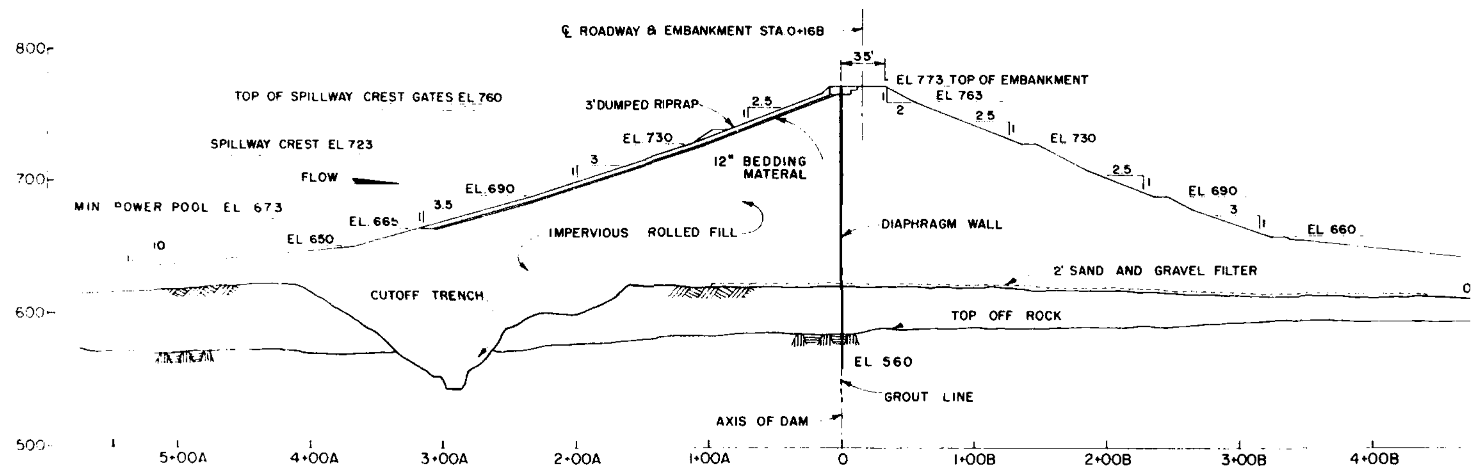

STA 57+49.30 L
P-1097
S-1096
STA 56+63.80
P-1059
S-1058
STA 55+51.30 L
P-1009
℄ CONCRETE DIAPHRAGM WALL AND DAM AXIS STA 0+00 A & B
℄ EMBANKMENT AND ROADWAY STA 0+168
PLAN
TOP OF EMBANKMENT EL 773.0
TOP OF ROCK
BASE OF DIAPHRAGM WALL EL 600
APPROX BASE OF GROUT LINE
ELEVATION IN FEET MSL
770
750
700
650
600
550
500
59+00L
58+00L
57+00L
56+00L
55+50 L
PROFILE
LEGEND
TOP OF ROCK
CAVITY ENCOUNTERED DURING EXCAVATION
COMPLETED ELEMENT
REVISION
DATE
DESCRIPTION
GRAPHIC SCALE
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE
DRAWN
CHECKED
TRACED
COMPARED
WOLF CREEK RESERVOIR PROJECT
DAM
PHASE II CONCRETE DIAPHRAGM WALL
SOLUTION FEATURES
STA 55+50L TO STA 62+50L
ENGINEER
SUBMITTED
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E DISTRICT ENGINEER
SCALE
SPEC NO
DRAWING NUMBER
DATE
SHEET
02-52/250A

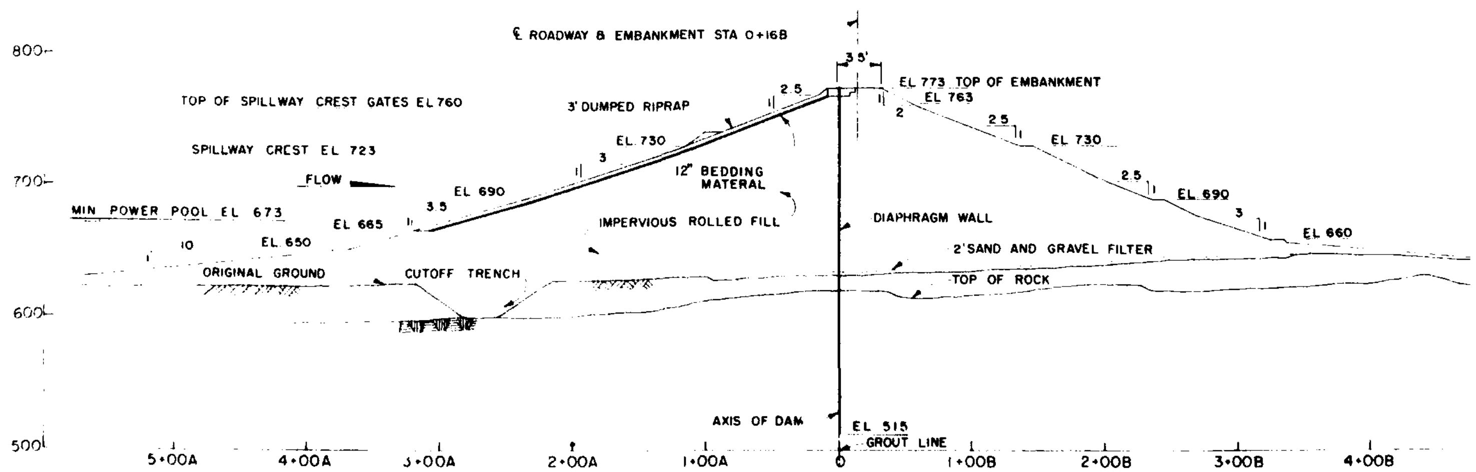
PLATE A-43



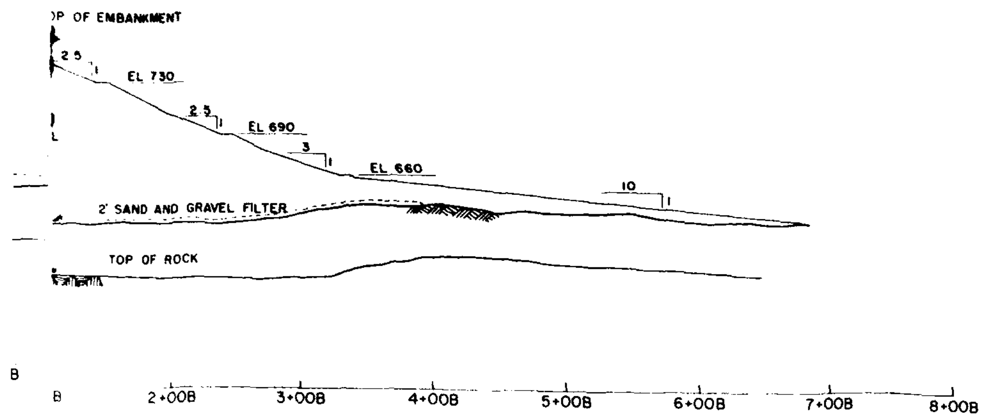
STATION 46+00L

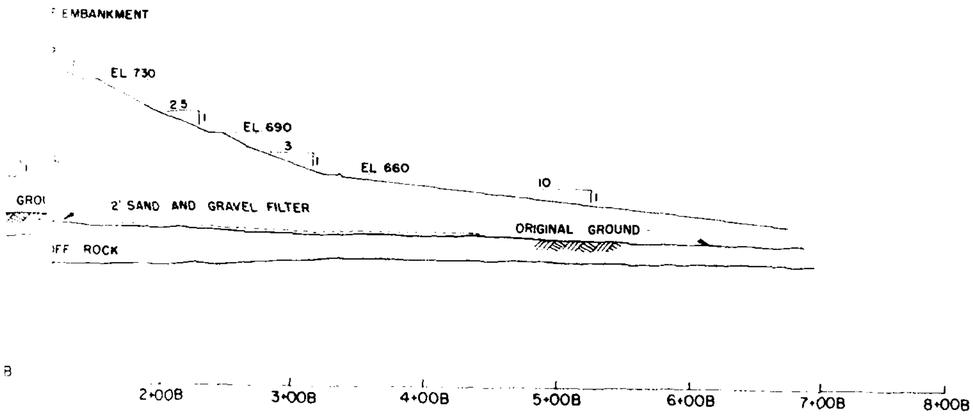


STATION 50+00L



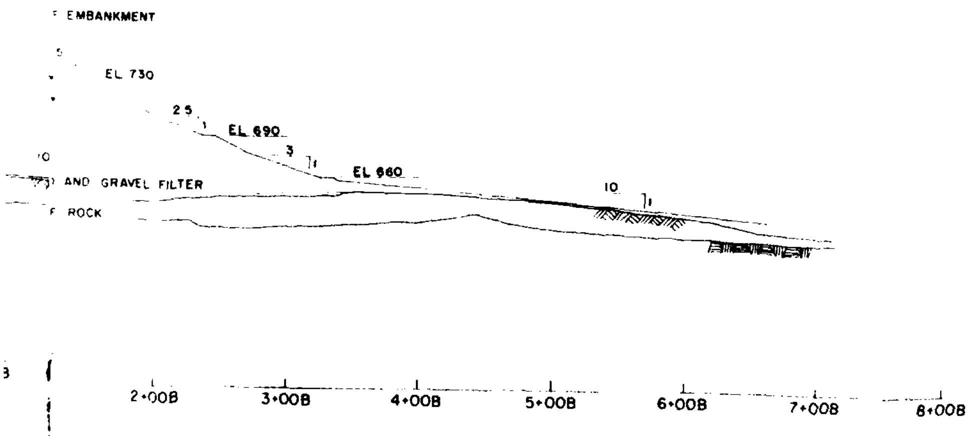
STATION 52+80L





NOTES

1. FOR GENERAL PLAN SEE DWG Q2-52/247
2. FOR PLAN AND PROFILE ALONG DIAPHRAGM WALL SEE DWGS Q2-52/248 THROUGH 250.



REVISION	DATE	ZONE AND DESCRIPTION	BY	CHKD
1	8-3-81	REVISED "AS CONSTRUCTED"	L.L.	

50' 0 50' 100'

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN A.G.C.
CHECKED W.D.
TRACED
COMPARED

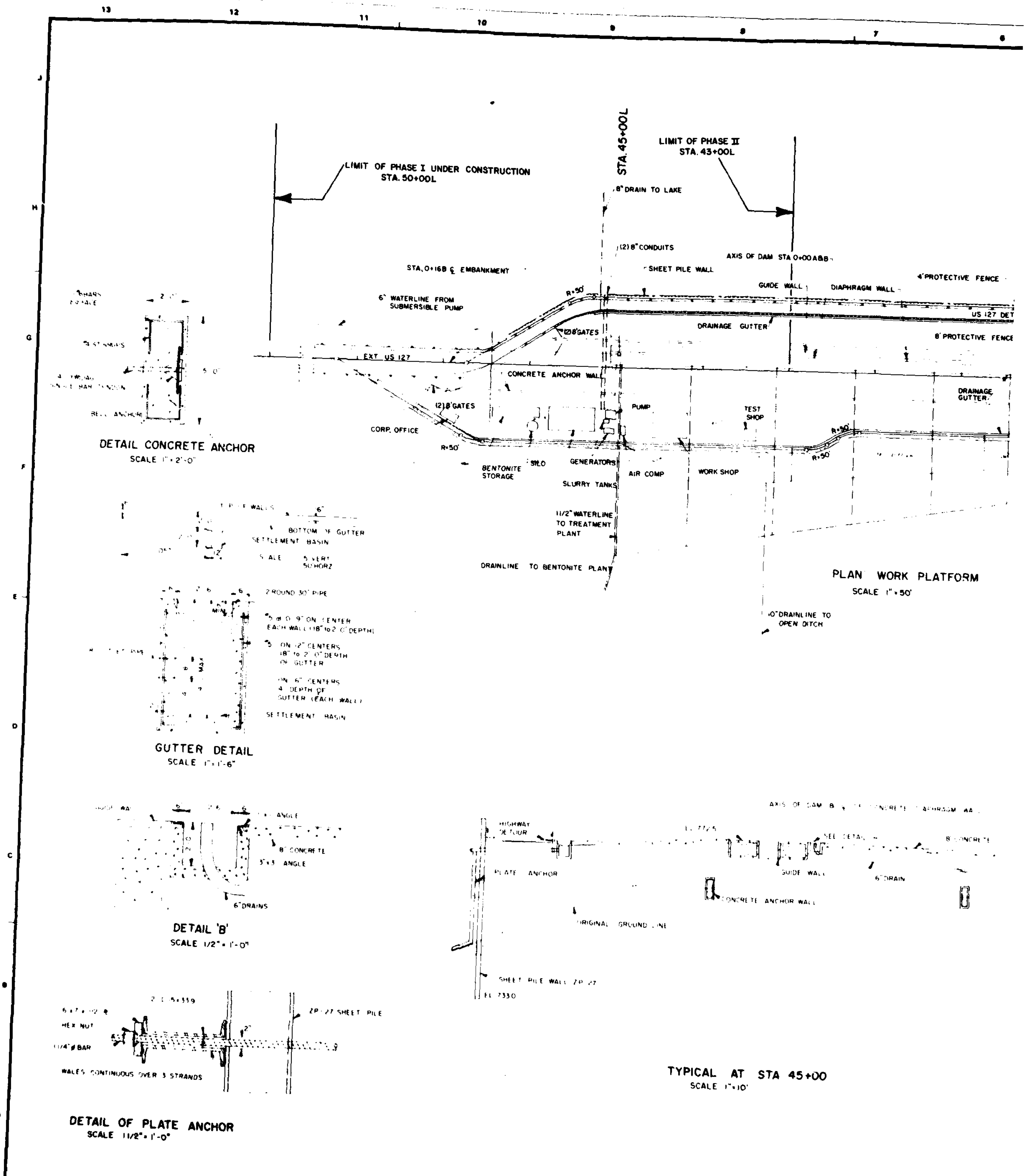
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

PHASE II EMBANKMENT DIAPHRAGM WALL SECTIONS

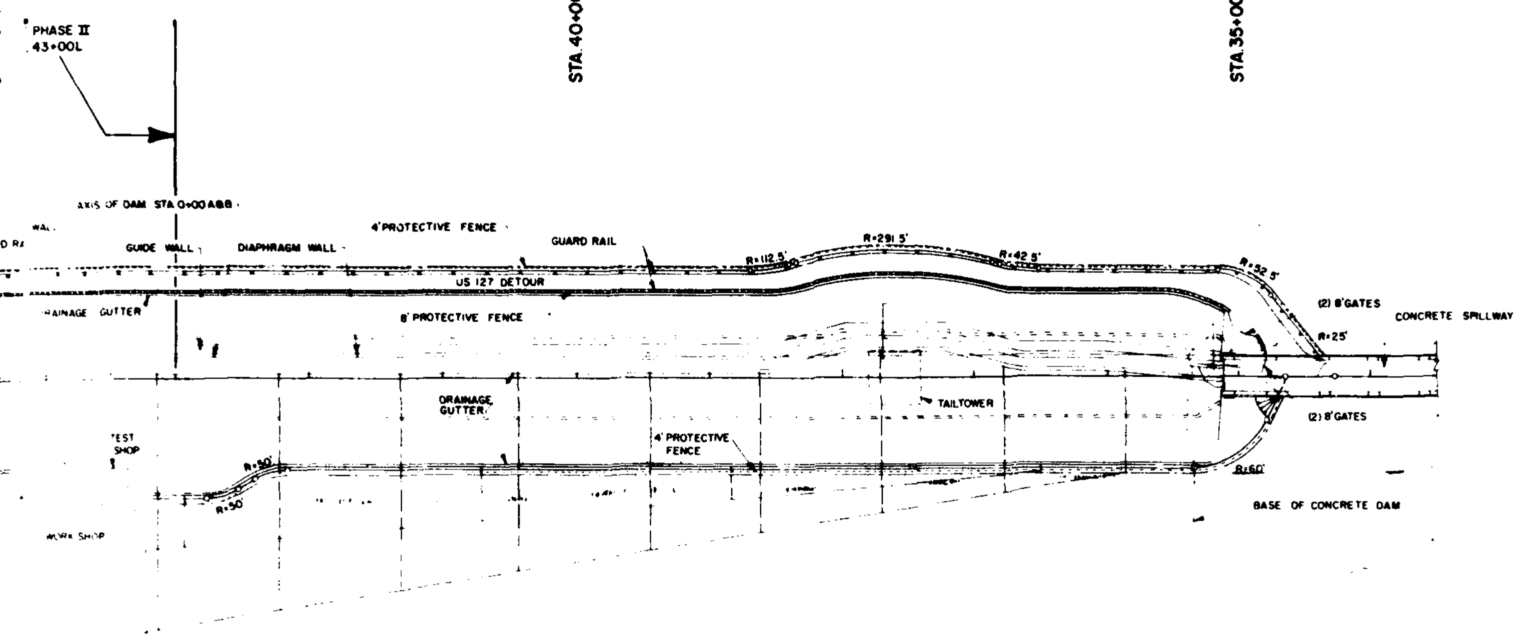
SUBMITTED
CHIEF, FOUNDATION AND MATERIALS BRANCH
APPROVAL RECOMMENDED
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
SCALE 1" = 50'
DATE APRIL 1977
DRAWING NUMBER Q2-52/251.1

PLATE A-44

RECORD DRAWING AS CONSTRUCTED
7 MAY 1981



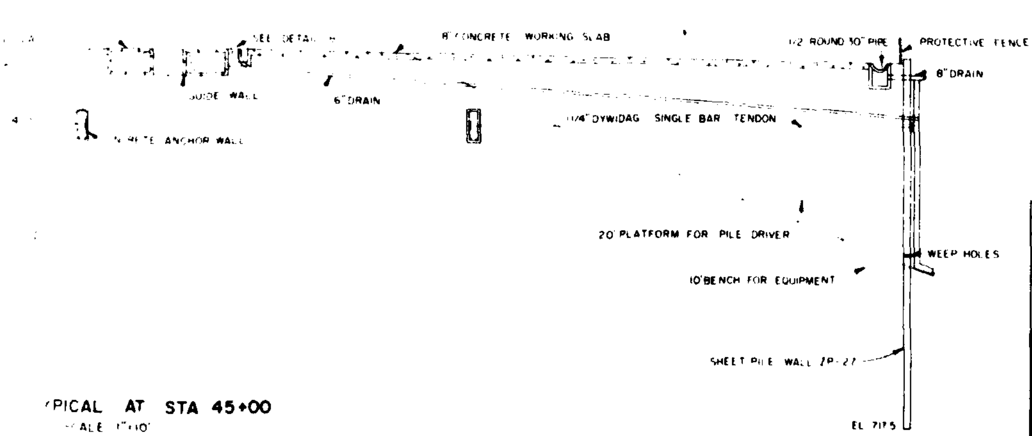
DETAIL CONCRETE ANCHOR
SCALE 1"=2'-0"
BELL ANCHOR
GUTTER DETAIL
SCALE 1"=1'-6"
SETTLEMENT BASIN
DETAIL 'B'
SCALE 1/2"=1'-0"
8" CONCRETE
6" DRAINS
DETAIL OF PLATE ANCHOR
SCALE 1 1/2"=1'-0"
HEX NUT
1 1/4" ⌀ BAR
WALES CONTINUOUS OVER 3 STRANDS
ZP-27 SHEET PILE
LIMIT OF PHASE I UNDER CONSTRUCTION
STA. 50+00L
STA. 45+00L
LIMIT OF PHASE II
STA. 43+00L
8" DRAIN TO LAKE
(2) 8" CONDUITS
AXIS OF DAM STA 0+00 ABB
STA. 0+16B ℄ EMBANKMENT
SHEET PILE WALL
GUIDE WALL
DIAPHRAGM WALL
4' PROTECTIVE FENCE
6" WATERLINE FROM SUBMERSIBLE PUMP
R=50'
US 127 DET
DRAINAGE GUTTER
8' PROTECTIVE FENCE
(2) 8" GATES
EXT. US 127
CONCRETE ANCHOR WALL
DRAINAGE GUTTER
(2) 8" GATES
PUMP
TEST SHOP
CORP. OFFICE
BENTONITE STORAGE
SILO
GENERATORS
AIR COMP
WORK SHOP
SLURRY TANKS
1 1/2" WATERLINE TO TREATMENT PLANT
DRAINLINE TO BENTONITE PLANT
PLAN WORK PLATFORM
SCALE 1"=50'
10" DRAINLINE TO OPEN DITCH
HIGHWAY DETOUR
PLATE ANCHOR
GUIDE WALL
6" DRAIN
CONCRETE ANCHOR WALL
ORIGINAL GROUND LINE
SHEET PILE WALL ZP-27
EL 7330
TYPICAL AT STA 45+00
SCALE 1"=10'



PLAN WORK PLATFORM

SCALE 1" = 50'

10" DRAINLINE TO OPEN DITCH



TYPICAL AT STA 45+00

SCALE 1" = 10'

REVISION	DATE	DESCRIPTION	BY	CHKD
1.	5-9-77	ADDED CONTRACTORS WORK LIMITS	AGC	AJD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

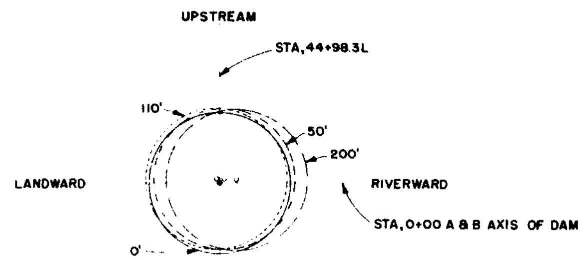
DRAWN: A CHAPMAN
CHECKED: A DUNN
TRACED:
COMPARED:

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

PHASE I WORK PLATFORM

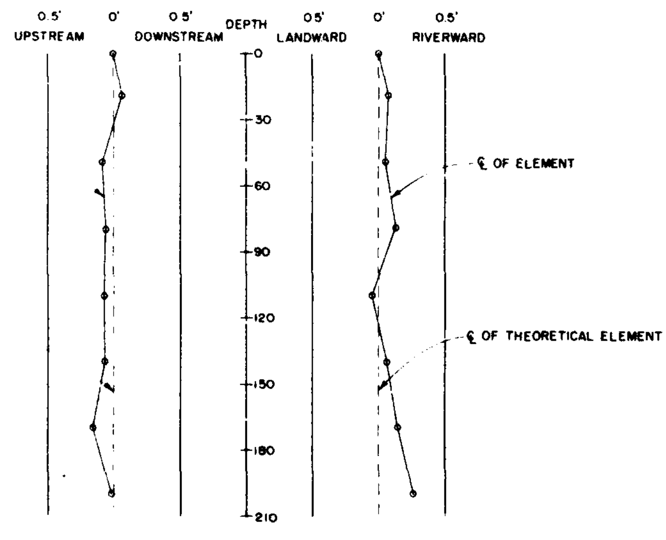
SUBMITTED:
APPROVED:
COLONEL, C E DISTRICT ENGINEER
APPROVAL RECOMMENDED:
SCALE: AS SHOWN
DATE: APRIL 1977
SHEET ___ OF ___ Q2-52/253.1

PLATE A-45

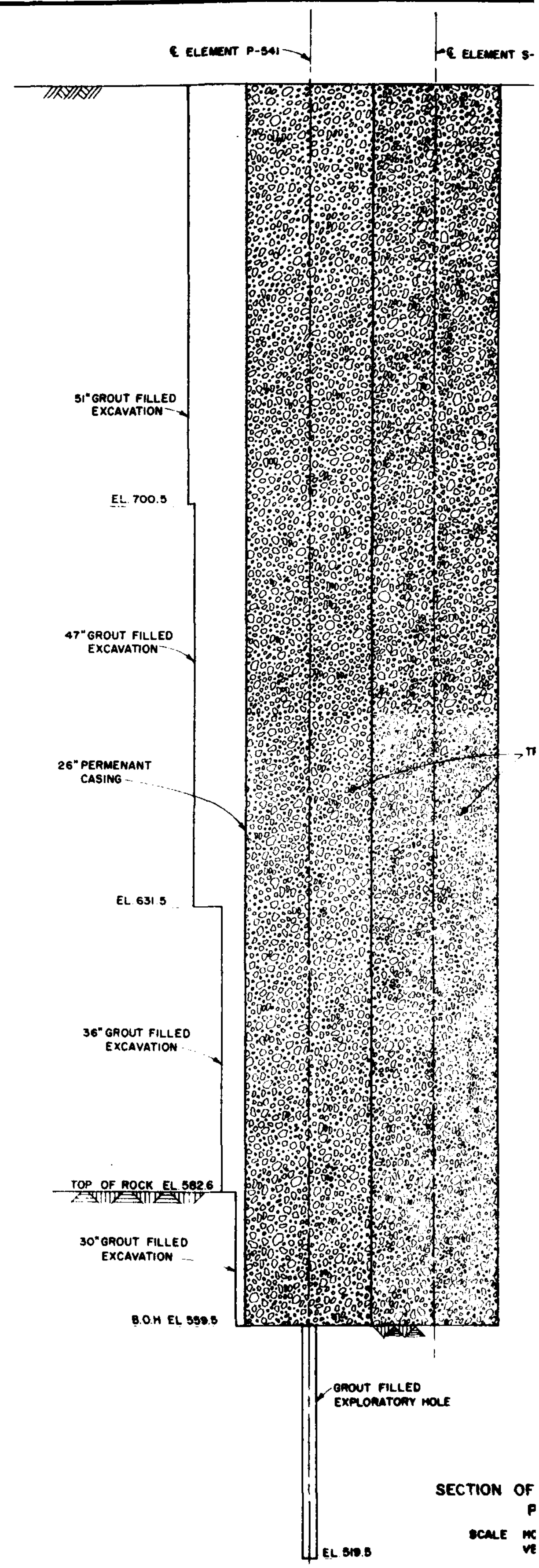


PLAN OF VERTICALITY
SCALE 1"=1'-0"

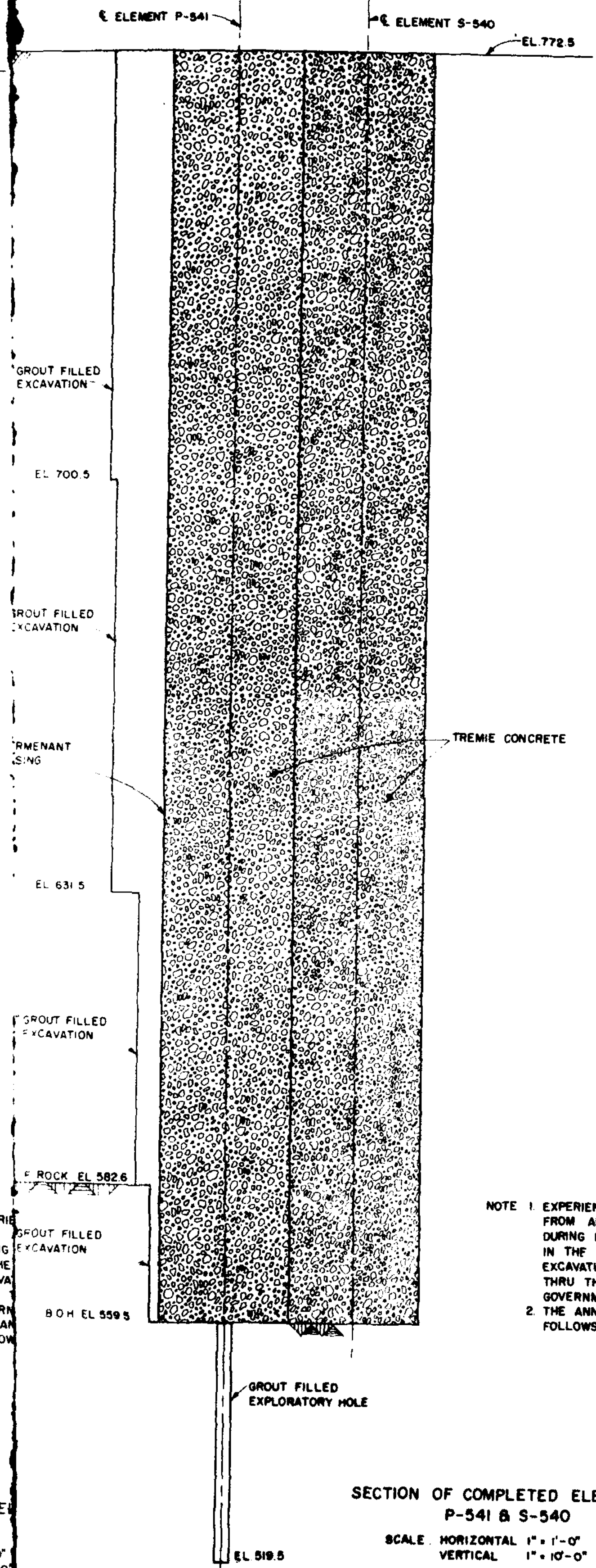
DEPTH	US/DS	LW/RW
0'	0.0	0.0
20'	0.055'DS	0.06'RW
50'	0.075'US	0.04'RW
80'	0.050'US	0.12' RW
110'	0.06'US	0.06'LW
140'	0.06'US	0.05'RW
170'	0.15' US	0.13'RW
200'	0.015'US	0.25'RW



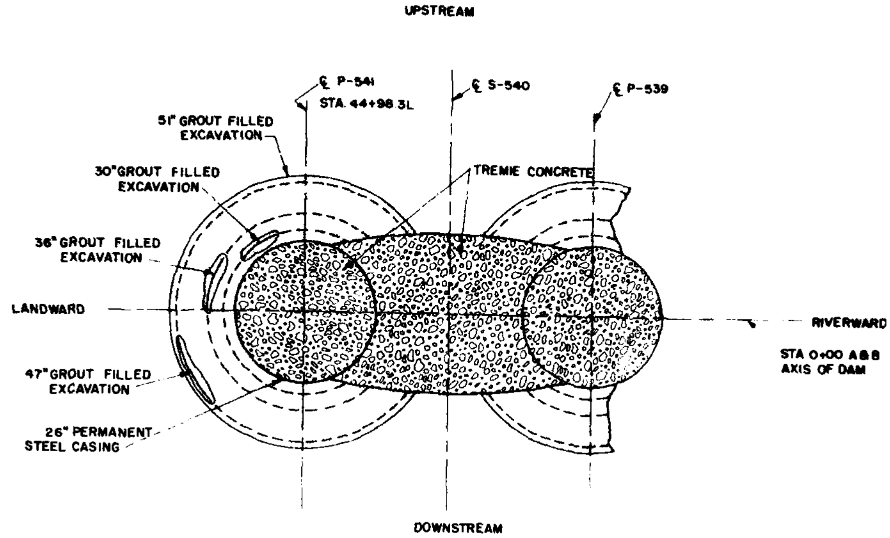
PROFILE OF VERTICALITY
SCALE HORIZONTAL 1" = 0'-6"
VERTICAL 1" = 30'-0"



SECTION OF
P
SCALE HC
VE



SECTION OF COMPLETED ELEMENTS
P-541 & S-540
SCALE: HORIZONTAL 1" = 1'-0"
VERTICAL 1" = 10'-0"



PLAN OF COMPLETED ELEMENTS
SCALE 1" = 1'-0"

NOTE 1. EXPERIENCE WITH PHASE I WORK HAS SHOWN THAT CONCRETE FROM ADJACENT SECONDARY ELEMENTS MAY BE ENCOUNTERED DURING EXCAVATION OF OTHER DIAPHRAGM WALL ELEMENTS. IN THE EVENT THAT CONCRETE IS ENCOUNTERED WHILE EXCAVATING ANY ELEMENTS, THE CONTRACTOR SHALL EXCAVATE THRU THIS CONCRETE AT NO ADDITIONAL COST TO THE GOVERNMENT.

2. THE ANNULAR SPACE GROUT MIX DESIGN BY WEIGHT IS AS FOLLOWS:
50% WATER
25% CEMENT
22% — 28% MINERAL FILLER
3% — 7% BENTONITE

REVISION	DATE	DESCRIPTION	BY
1	5-9-77	ADDED GROUT PROPERTIES AND NOTE	A.G.

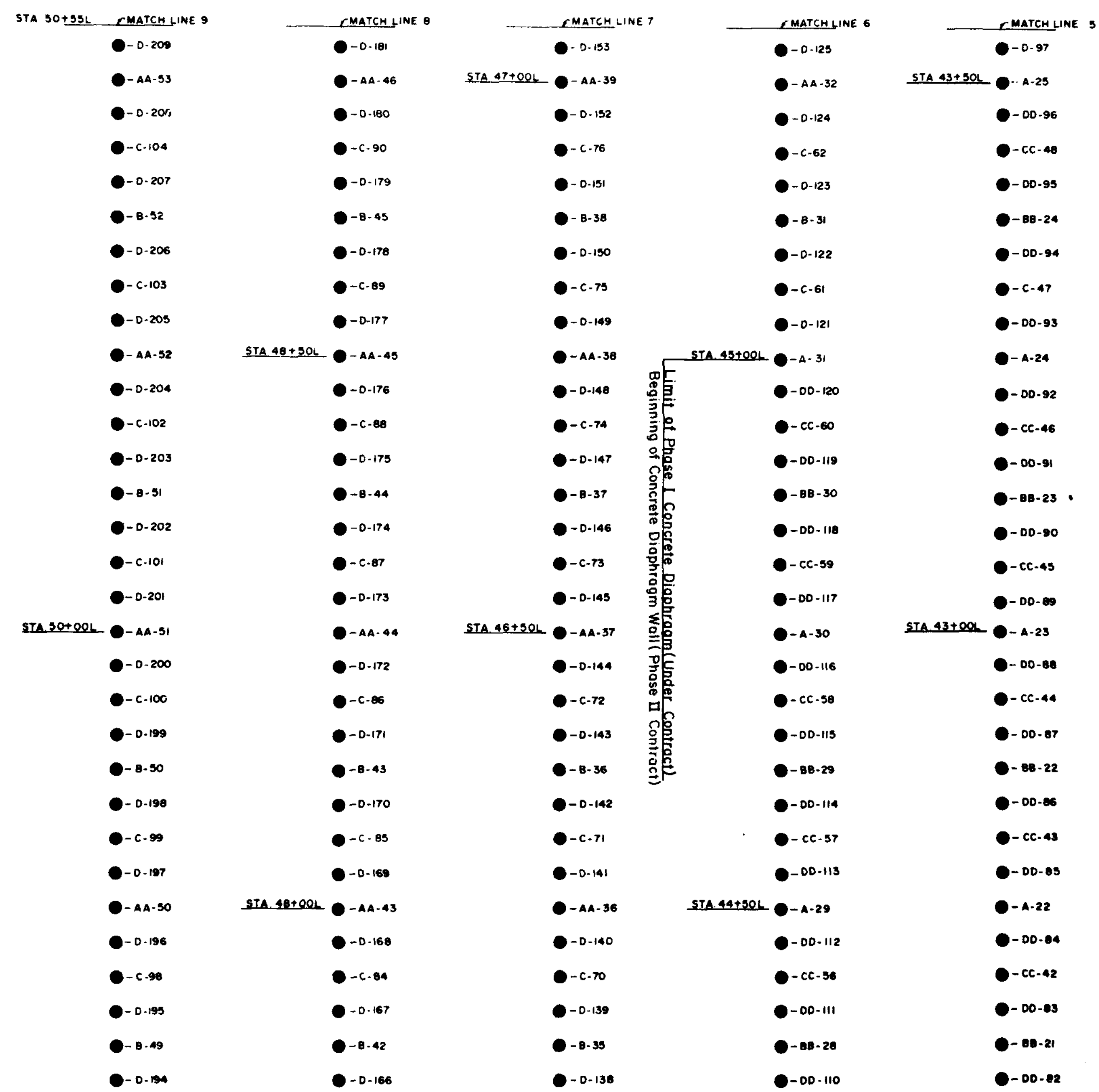
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN A.G. CHAPMAN
CHECKED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

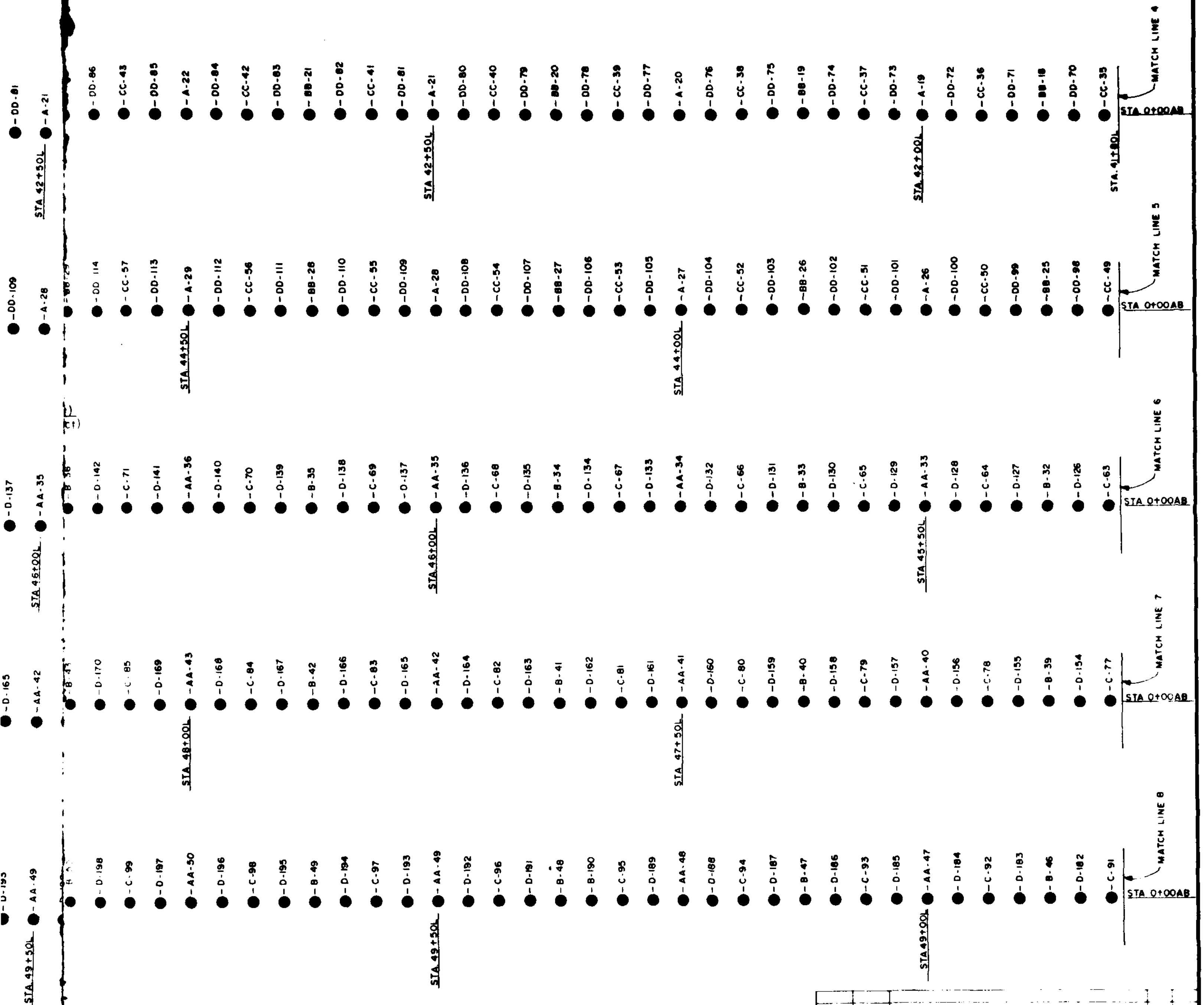
EXISTING DIAPHRAGM WALL
ELEMENT P-541 DETAILS

SCALE AS SHOWN
DATE APRIL 1977
02-52/239



MATCH LINE 9
STA 50+55L
STA 50+00L
D-209
AA-53
D-208
C-104
D-207
B-52
D-206
C-103
D-205
AA-52
D-204
C-102
D-203
B-51
D-202
C-101
D-201
AA-51
D-200
C-100
D-199
B-50
D-198
C-99
D-197
AA-50
D-196
C-98
D-195
B-49
D-194
MATCH LINE 8
STA 48+50L
STA 48+00L
D-181
AA-46
D-180
C-90
D-179
B-45
D-178
C-89
D-177
AA-45
D-176
C-88
D-175
B-44
D-174
C-87
D-173
AA-44
D-172
C-86
D-171
B-43
D-170
C-85
D-169
AA-43
D-168
C-84
D-167
B-42
D-166
MATCH LINE 7
STA 47+00L
STA 46+50L
D-153
AA-39
D-152
C-76
D-151
B-38
D-150
C-75
D-149
AA-38
D-148
C-74
D-147
B-37
D-146
C-73
D-145
AA-37
D-144
C-72
D-143
B-36
D-142
C-71
D-141
AA-36
D-140
C-70
D-139
B-35
D-138
Limit of Phase I Concrete Diaphragm (Under Contract)
Beginning of Concrete Diaphragm Wall (Phase II Contract)
MATCH LINE 6
STA 45+00L
STA 44+50L
D-125
AA-32
D-124
C-62
D-123
B-31
D-122
C-61
D-121
A-31
DD-120
CC-60
DD-119
BB-30
DD-118
CC-59
DD-117
A-30
DD-116
CC-58
DD-115
BB-29
DD-114
CC-57
DD-113
A-29
DD-112
CC-56
DD-111
BB-28
DD-110
MATCH LINE 5
STA 43+50L
STA 43+00L
D-97
A-25
DD-96
CC-48
DD-95
BB-24
DD-94
C-47
DD-93
A-24
DD-92
CC-46
DD-91
BB-23
DD-90
CC-45
DD-89
A-23
DD-88
CC-44
DD-87
BB-22
DD-86
CC-43
DD-85
A-22
DD-84
CC-42
DD-83
BB-21
DD-82

NOTES



NOTES

1 All holes shown were drilled along Sta. 0+00AB.

2 For geologic sections along the wall alignment see Dwg. Nos. Q2-52/262I, Q2-52/263 and Q2-52/264

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-9-77	GENERAL REVISIONS		

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

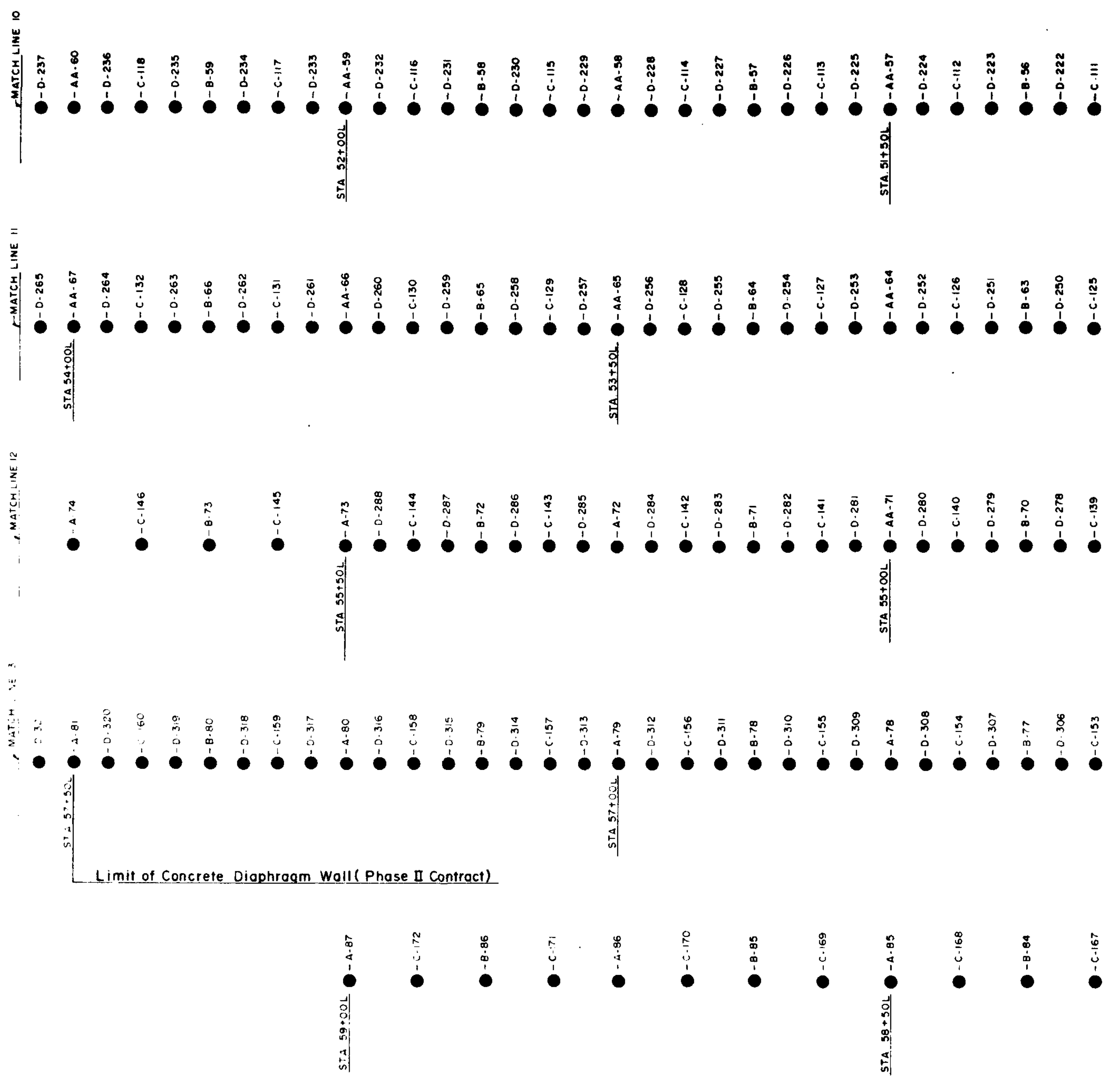
DRAWN GAH
CHECKED
TRACED
COMPARED
GEOLOGIST

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION
STA 41+80L to 50+55L
HOLE LOCATIONS

SUBMITTED
APPROVAL RECOMMENDED
APPROVED
SCALE 1" = 5'
SPEC NO
DRAWING NUMBER
DATE
SHEET OF
Q2-52/260.1

PLATE A-47

7 May 1981

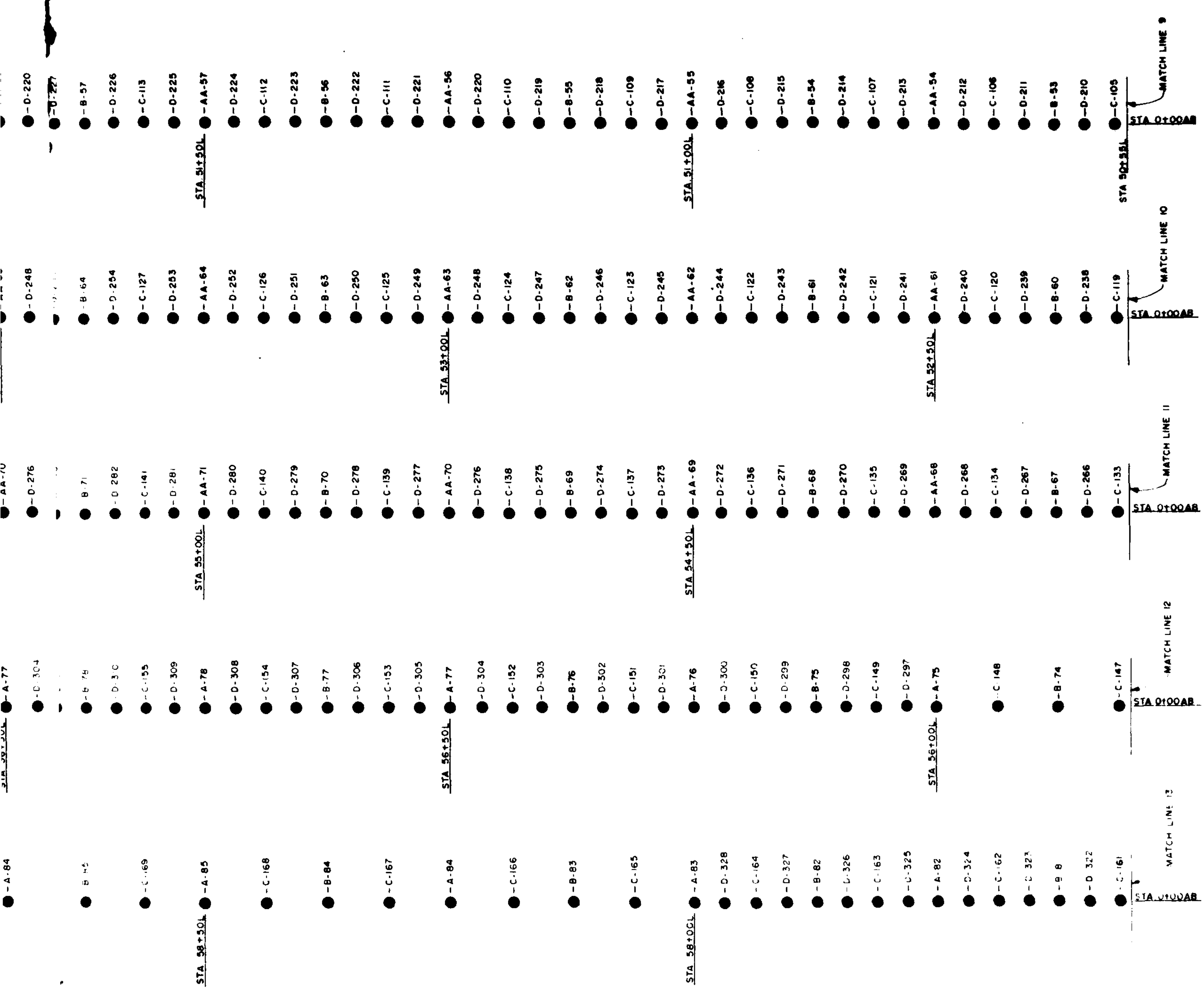


NOTES:

1. All h

2. For g

Dwg



...own were
sections
...2-52/26

NOTES:

1. All holes shown were drilled along Sta. 0+00AB.

2. For geologic sections along wall alignment see Dwg. Nos. 02-52/264 thru 02-52/267.

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5 16 77	MINOR REVISION		

GRAPHIC SCALE

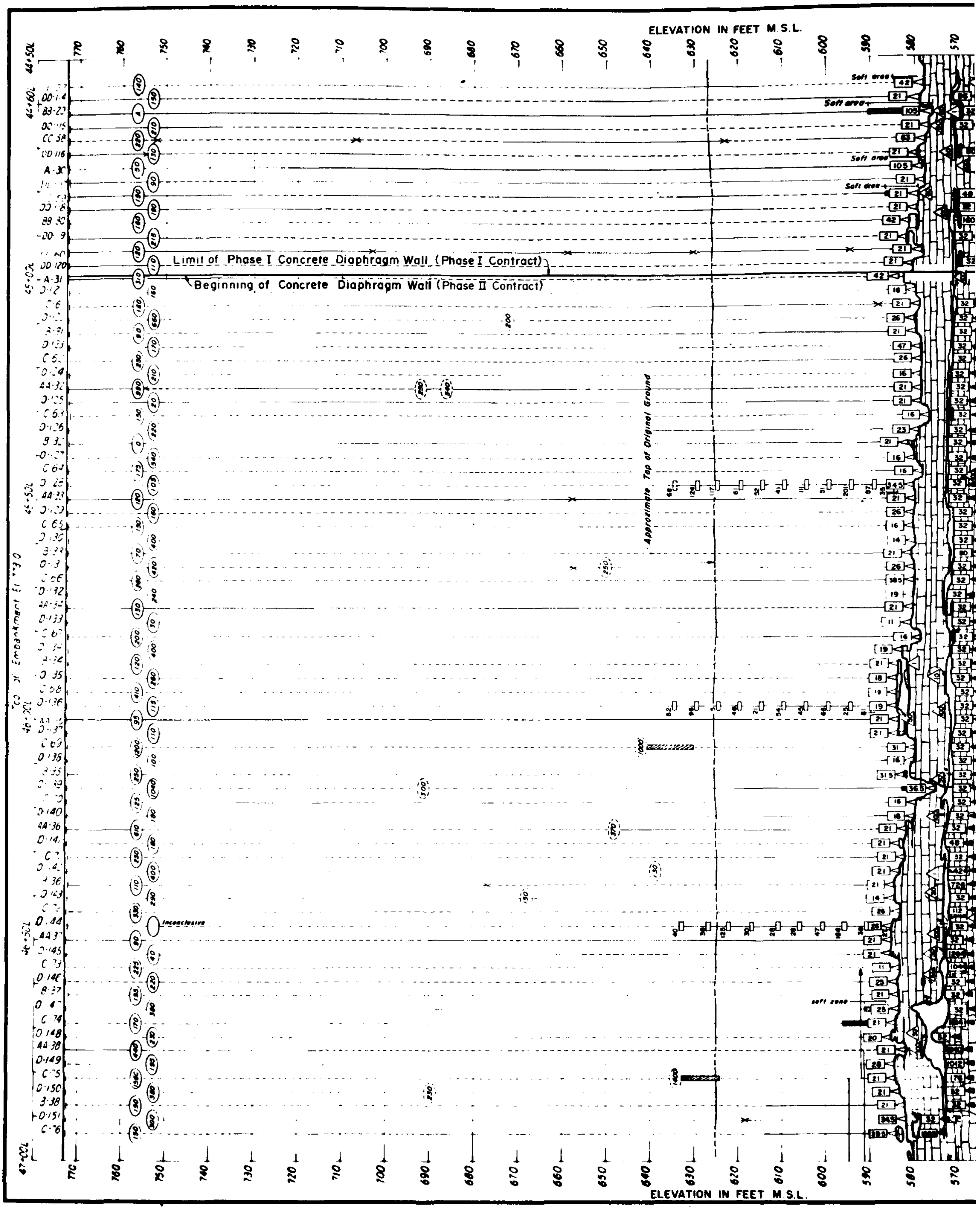
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION
STA 50+55L to 59+00L
HOLE LOCATIONS

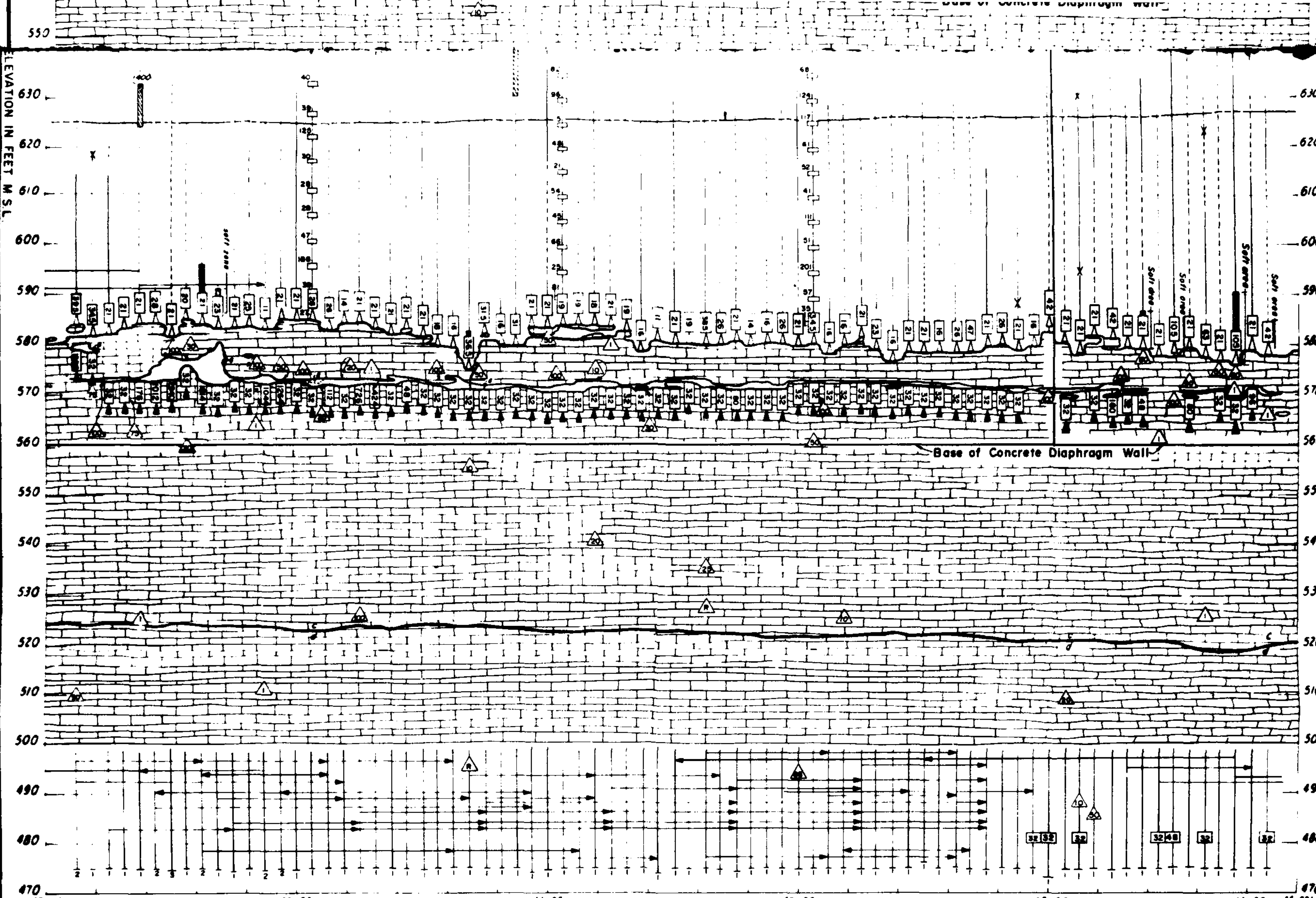
DRAWN: GAH
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
DATE
APPROVAL RECOMMENDED
SCALE: 1" = 5'
DRAWING NUMBER
02-52/261.1

PLATE A-48

Duane A. Dyer 7 May 1981



ELEVATION IN FEET M.S.L.
Limit of Phase I Concrete Diaphragm Wall (Phase I Contract)
Beginning of Concrete Diaphragm Wall (Phase II Contract)
Approximate Top of Original Ground
Soft area
Inconclusive
soft zone
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during drilling
- Loss of circulation
- Zone of partial mud loss
- Blow-Count-drive sampler standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leiders - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG NO Q2-52/260.1
2. PHASE II 3-1/8 EXPLORATORY HOLES BEGIN AT STATION 40+50L, EXTEND TO STATION 45+00L AND ARE DESIGNATED BB, CC, AND DD. PHASE I 25 HOLES EXTEND TO STATION 45+00L AND ARE DESIGNATED A. PHASE III 3-1/8"cc EXPLORATORY HOLES BEGIN AT STATION 45+00L AND ARE DESIGNATED B,C, AND D. PHASE III EXPLORATORY HOLES EXTEND TO STATION 74+00L AND ARE DESIGNATED A,B,C, AND D
3. EMBANKMENT PORTION OF BB-29 WAS DRILLED WITH AN AIR CIRCULATING DRILL
4. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD
1	5-9-77	GENERAL REVISIONS	AG	

GRAPHIC SCALE

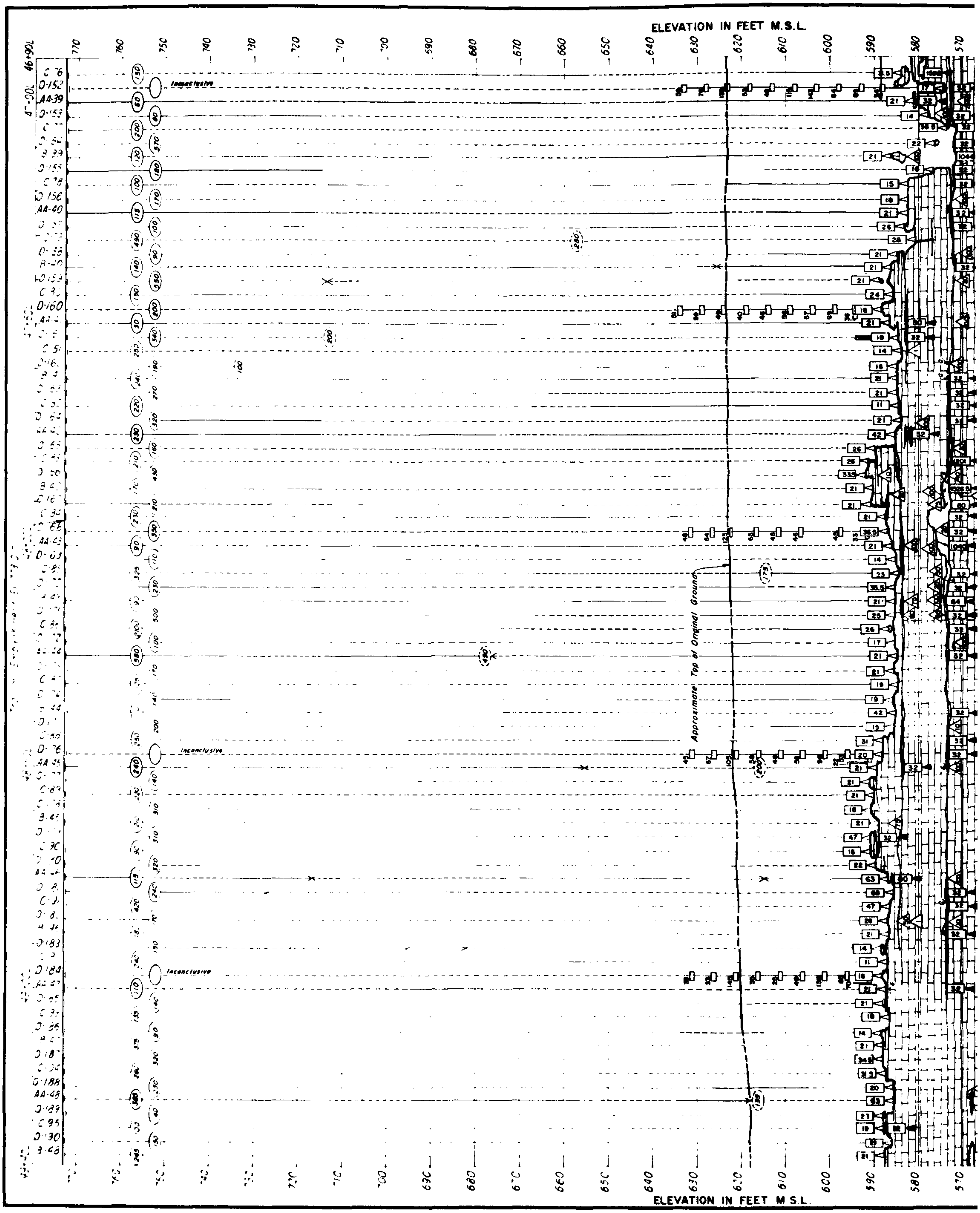
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

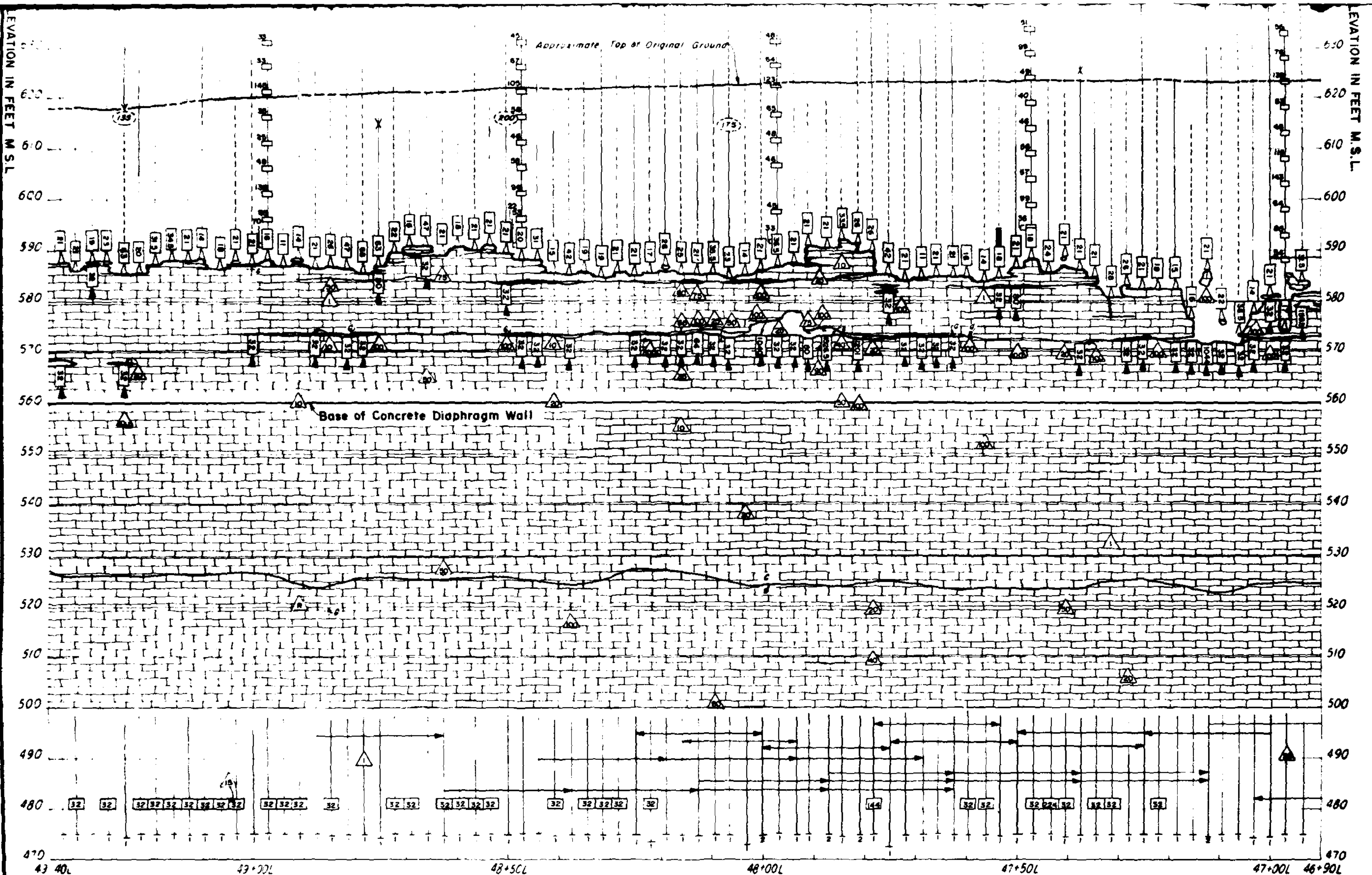
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

FOUNDATION EXPLORATION - PHASE II and III
STA 44+50L to 47+00L
GEOLOGIC SECTION

DRAWN: CHECKED: TRACED: COMPARED:
GEOLOGIST
SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED:
APPROVED: COLONEL, C.E. DISTRICT ENGINEER
DATE
SCALE 1" = 10' SPEC NO
DRAWING NUMBER
SHEET OF

Q2-52/262.1


ELEVATION IN FEET M.S.L.
Inconclusive
Approximate Top of Original Ground
Inconclusive
Inconclusive
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Blow-Count - drive-sampled, standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100 % drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES:

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG. NO. Q2 52/260
2. PHASE II 25'c.c. EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 74+00L AND ARE DESIGNATED A,B,C, AND D.
3. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM.

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

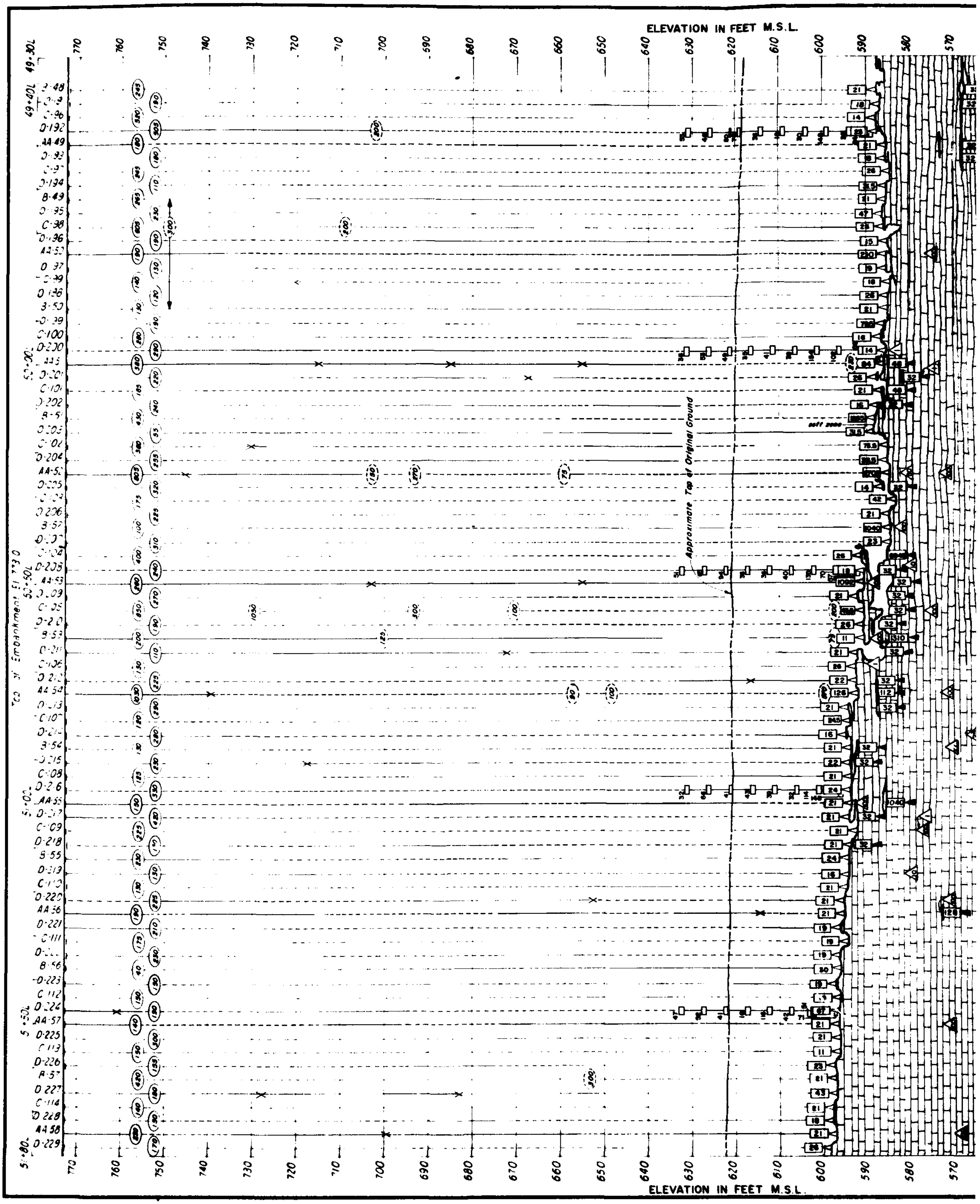
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

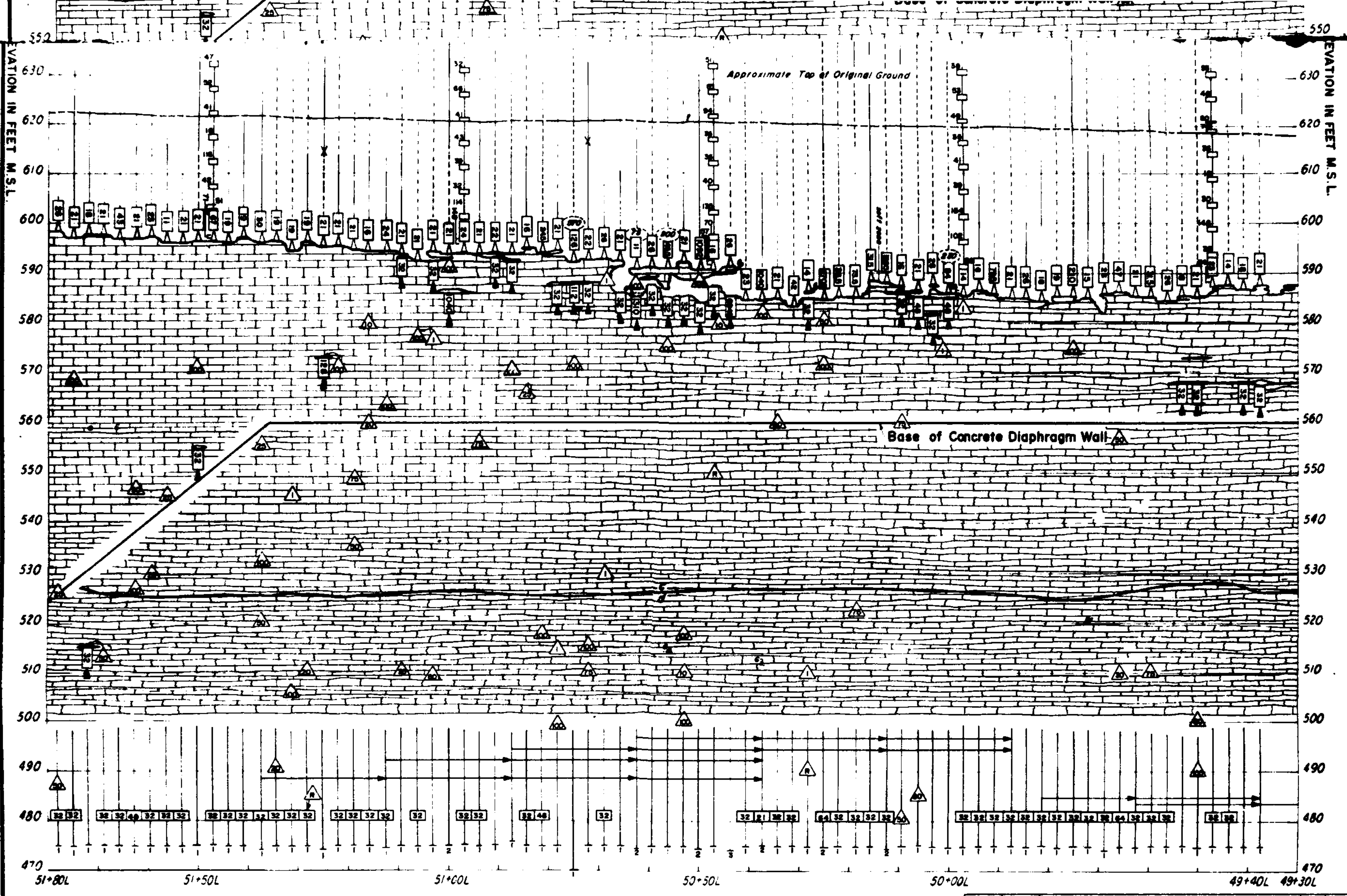
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE II and III
STA 46+90L to 49+40L
GEOLOGIC SECTION

DRAWN SLY
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
DATE
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
SCALE 1" = 10'
SPEC NO.
DRAWING NUMBER
SHEET OF
Q2-52/263

PLATE A-50

Q2-52/263


ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Blow-Count – drive-sampled, standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers-Catheys contact – All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES:

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG NOS. Q2-52/260 AND Q2-52/261
2. PHASE II 25' c c EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D
3. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

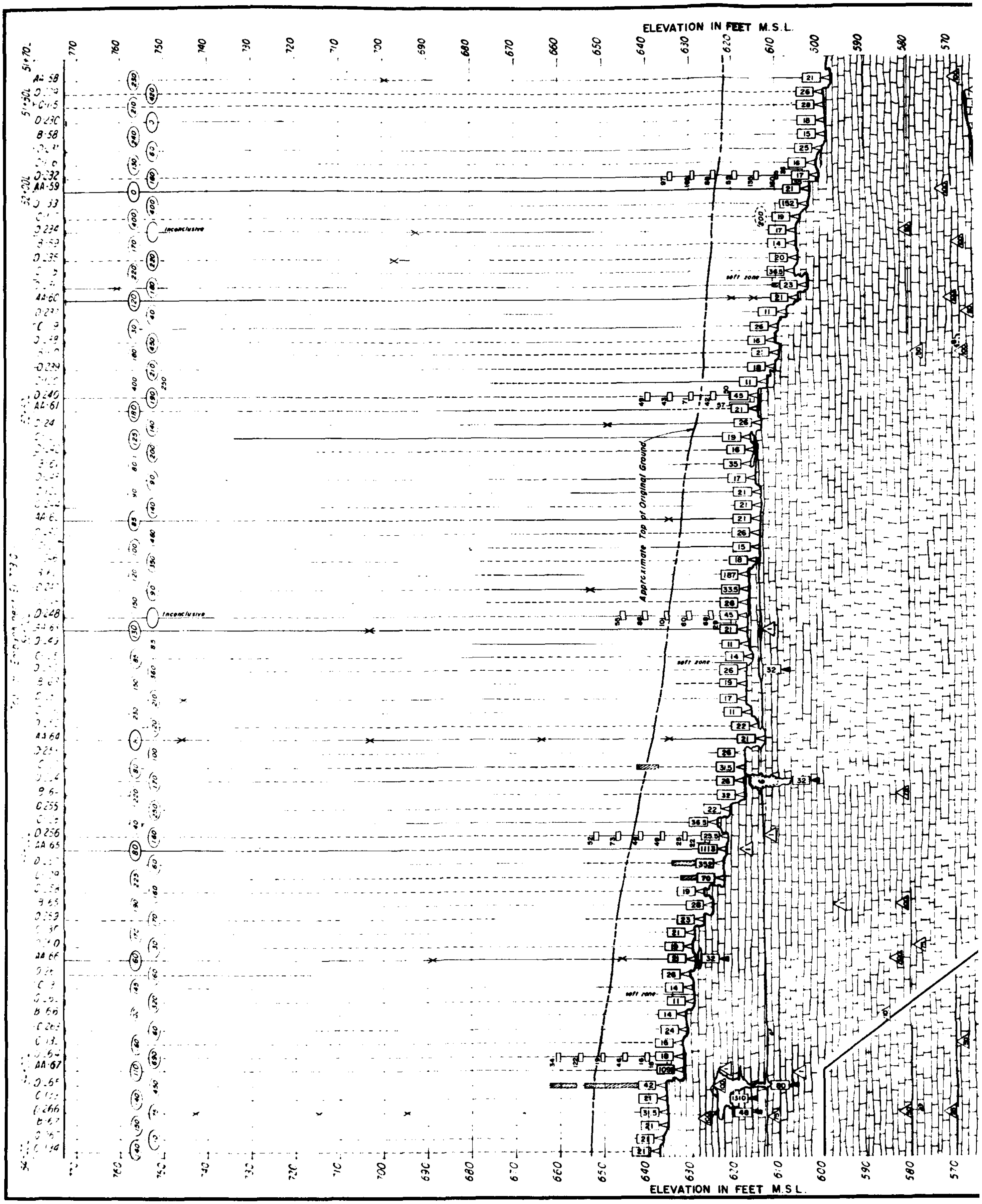
FOUNDATION EXPLORATION - PHASE II and III
STA 49+30L to 51+80L

GEOLOGIC SECTION

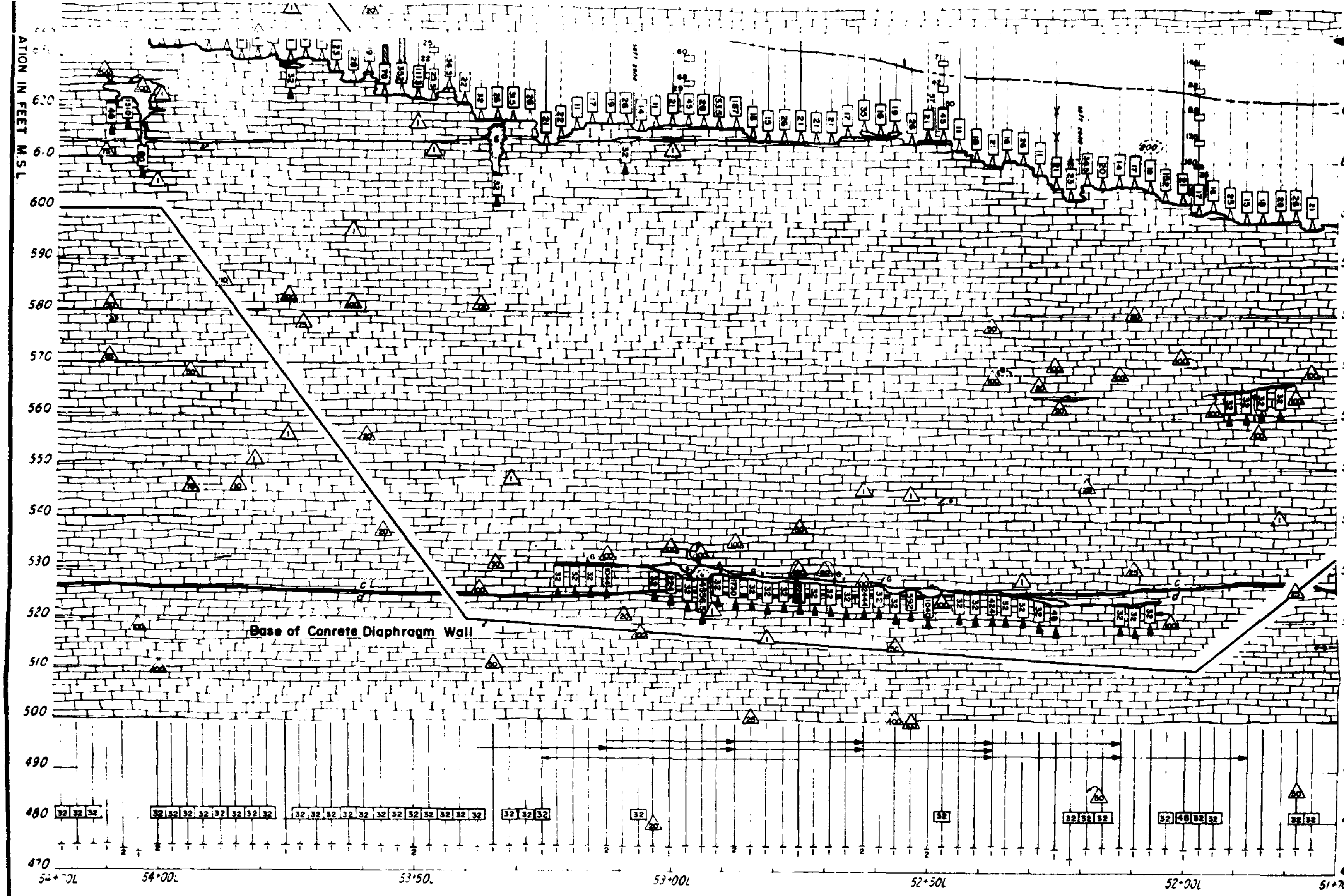
DRAWN: SAY
CHECKED:
TRACED:
COMPARED:
GEOLOGIST
SUBMITTED:
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVED:
COLONEL, C E DISTRICT ENGINEER
DATE:
APPROVAL RECOMMENDED:
SCALE: 1" = 10'
SPEC. NO.
DRAWING NUMBER
SHEET OF
Q2-52/264

7 May 1981

PLATE A-51 Q2-52/264



ELEVATION IN FEET M.S.L.
Approximate Top of Original Ground
Inconclusive
soft zone
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Blow-Counts - drive sample Standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100 % drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES:

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE DWG NO Q2-52/261.
2. PHASE II 25' c.c. EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D.
3. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

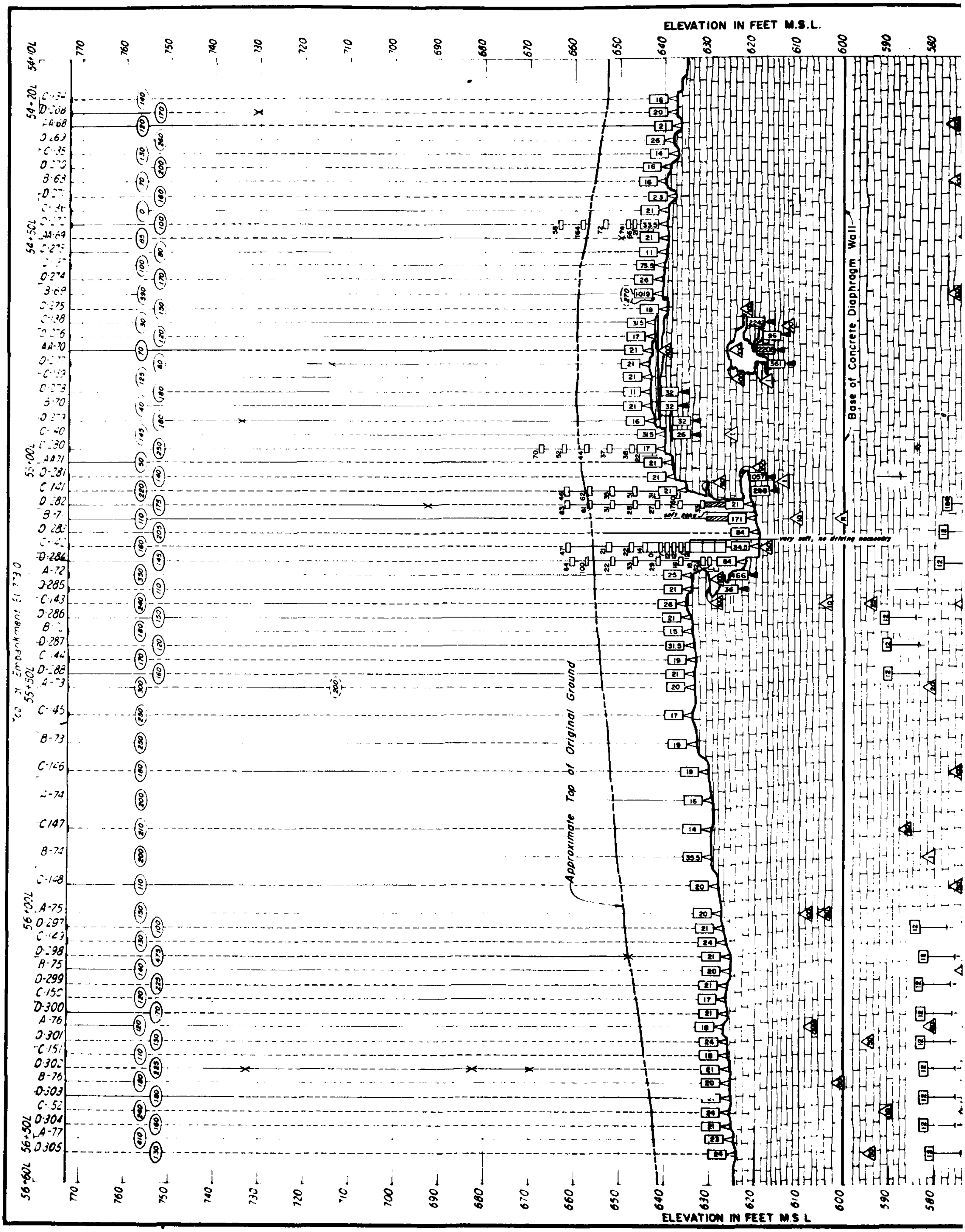
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE III
STA. 51+70L to 54+20L
GEOLOGIC SECTION

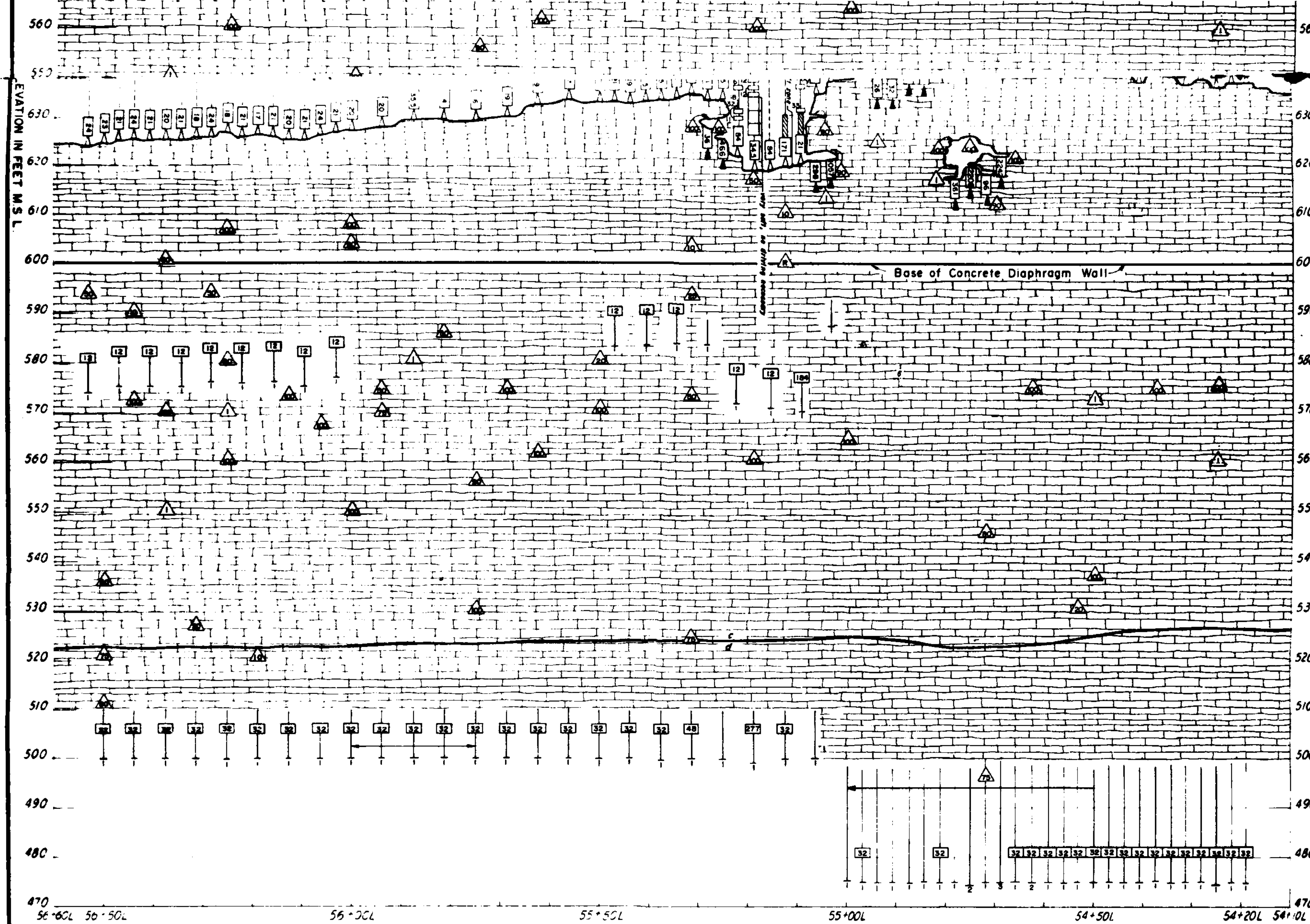
DRAWN CH
CHECKED
TRACED
COMPARED
GEOLOGIST
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, DISTRICT ENGINEER
DATE
SCALE 1" = 10'
SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/265

7 MAR 1981

PLATE A-52 Q2-52/265



ELEVATION IN FEET M.S.L.
Base of Concrete Diaphragm Wall
Approximate Top of Original Ground
Top of Embankment El 770
very soft, no driving necessary
soft zone
54+10L
54+20L
54+50L
55+00L
55+50L
56+00L
56+50L
56+60L
ELEVATION IN FEET M.S.L.



LEGEND:

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Blow-Counts - drive sample standard penetration
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact - All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES

1. FOR APPROXIMATE LOCATIONS OF ALL HOLES, SEE
2. HOLE C-138 INTERCEPTED HOLE AA-70 AT ELEVATION 516.6 AND REMAINED IN AA-70 TO BOTTOM OF HOLE
3. WHILE BACKFILLING HOLE C-138 GROUT SURFACED ALONG THE DOWNSTREAM TOE OF THE DAM AT STA 56+36.3, 4+05.6B at EL 640.7
4. PHASE II 25'cc EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 55+00L AND ARE DESIGNATED AA. PHASE III EXPLORATORY HOLES BEGIN AT STATION 45+00L AND EXTEND TO STATION 74+00L AND ARE DESIGNATED A, B, C, AND D
5. ALL 3-$\frac{1}{2}$ FOOT C.C. HOLES BETWEEN STA 55+00L AND STA 58+00L WERE DRILLED 50 FEET INTO ROCK AND THE ROCK PORTION OF EACH HOLE WAS BACKFILLED WITH NEAT CEMENT GROUT. ALL REMAINING HOLES WERE BACKFILLED WITH SANDED GROUT
6. ALL ELEVATIONS REFER TO MEAN SEA LEVEL SANDY HOOK DATUM

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

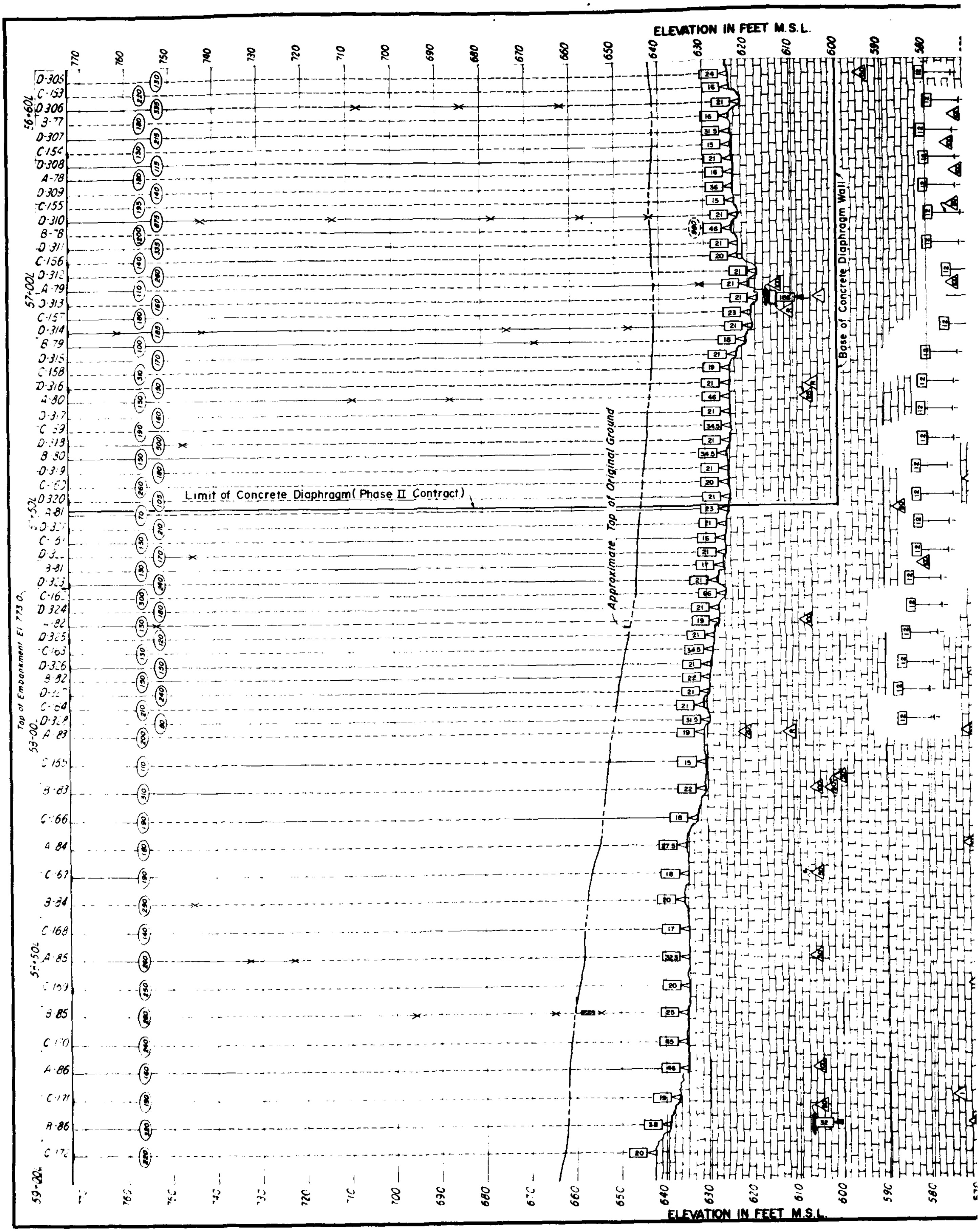
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

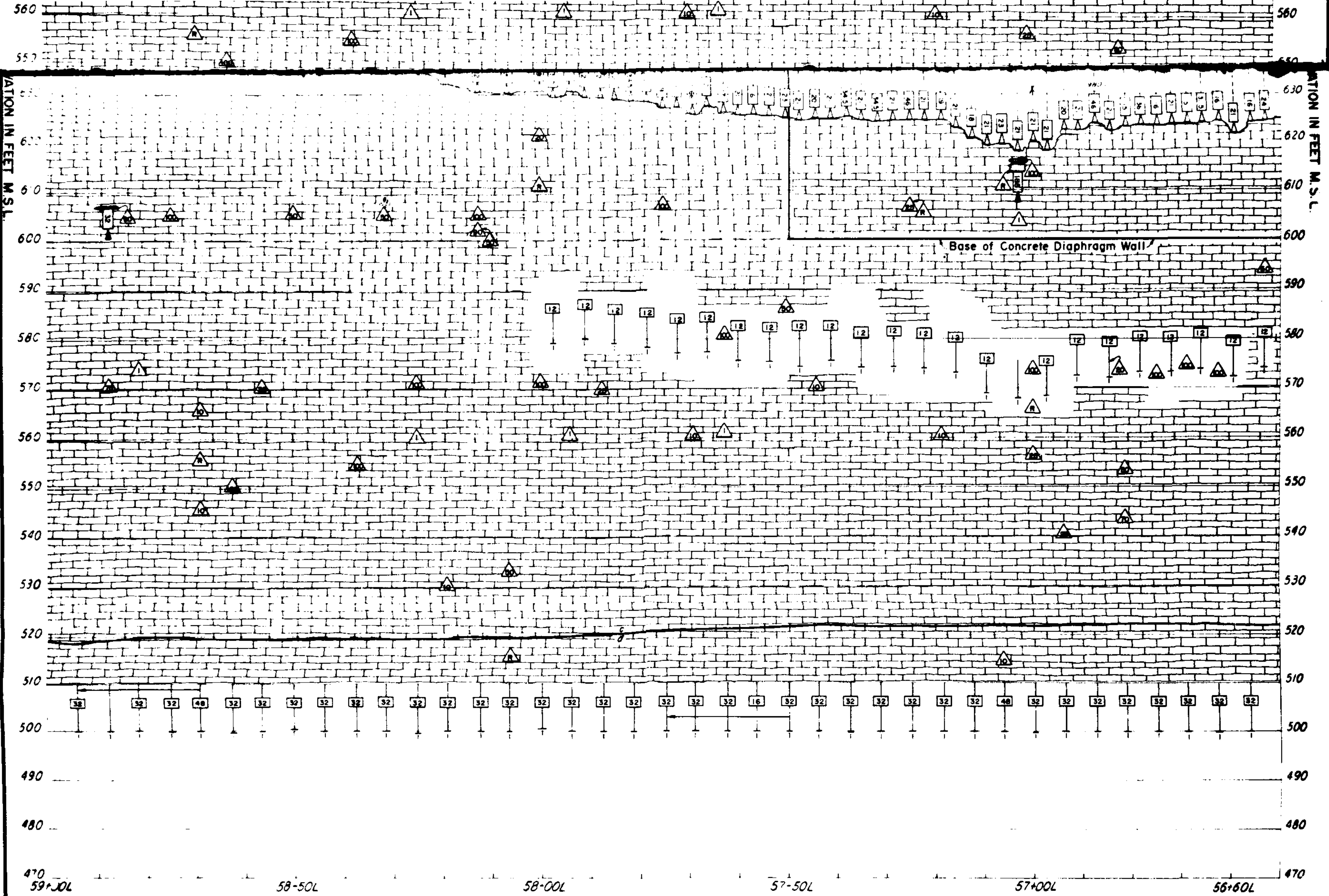
FOUNDATION EXPLORATION - PHASE II and III
STA 54+10L to 56+60L

GEOLOGIC SECTION

DRAWN:
CHECKED:
TRACED:
COMPARED:
GEOLOGIST
SUBMITTED:
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED:
APPROVED:
COLONEL, C.E. DISTRICT ENGINEER
SCALE: 1" = 10'
SPEC NO
DRAWING NUMBER



ELEVATION IN FEET M.S.L.
Limit of Concrete Diaphragm (Phase II Contract)
Approximate Top of Original Ground
Base of Concrete Diaphragm Wall
Top of Embankment El 773.0
56+60L
57+00L
57+50L
58+00L
58+50L
59+00L



LEGEND

- Point of mud loss during partial loss of circulation
- Zone of partial mud loss
- Gallons of mud lost per hole
- Gallons of mud lost when total loss of circulation occurs
- Connection between holes during drilling or rock grouting unless otherwise noted
- Soft area in overburden
- Grout encountered during drilling
- Leipers - Catheys contact — All members are crystalline, variably shaly Limestone
- Point of drillwater loss
- Percent of drillwater loss
- Intermittent drillwater return remainder of hole unless otherwise indicated
- 100% drillwater return
- Cubic feet of grout placed in overburden backfilling operation
- Cubic feet of grout placed in rock grouting
- Cubic feet of grout injected in holes in which no apparent openings were encountered
- Number of grout stages

NOTES:

1. For approximate locations of all holes See Dwg Q2-52/261.
2. The 3-⅛-foot c.c. holes between Sta 56+00L and 58+00L were drilled 50' into rock and the rock portion of each hole was backfilled with neat cement grout. All remaining 25-Foot, 12.5-Foot and 6.25-Foot c.c holes were backfilled with sanded grout.
3. All elevations refer to Mean Sea Level Sandy Hook Datum.

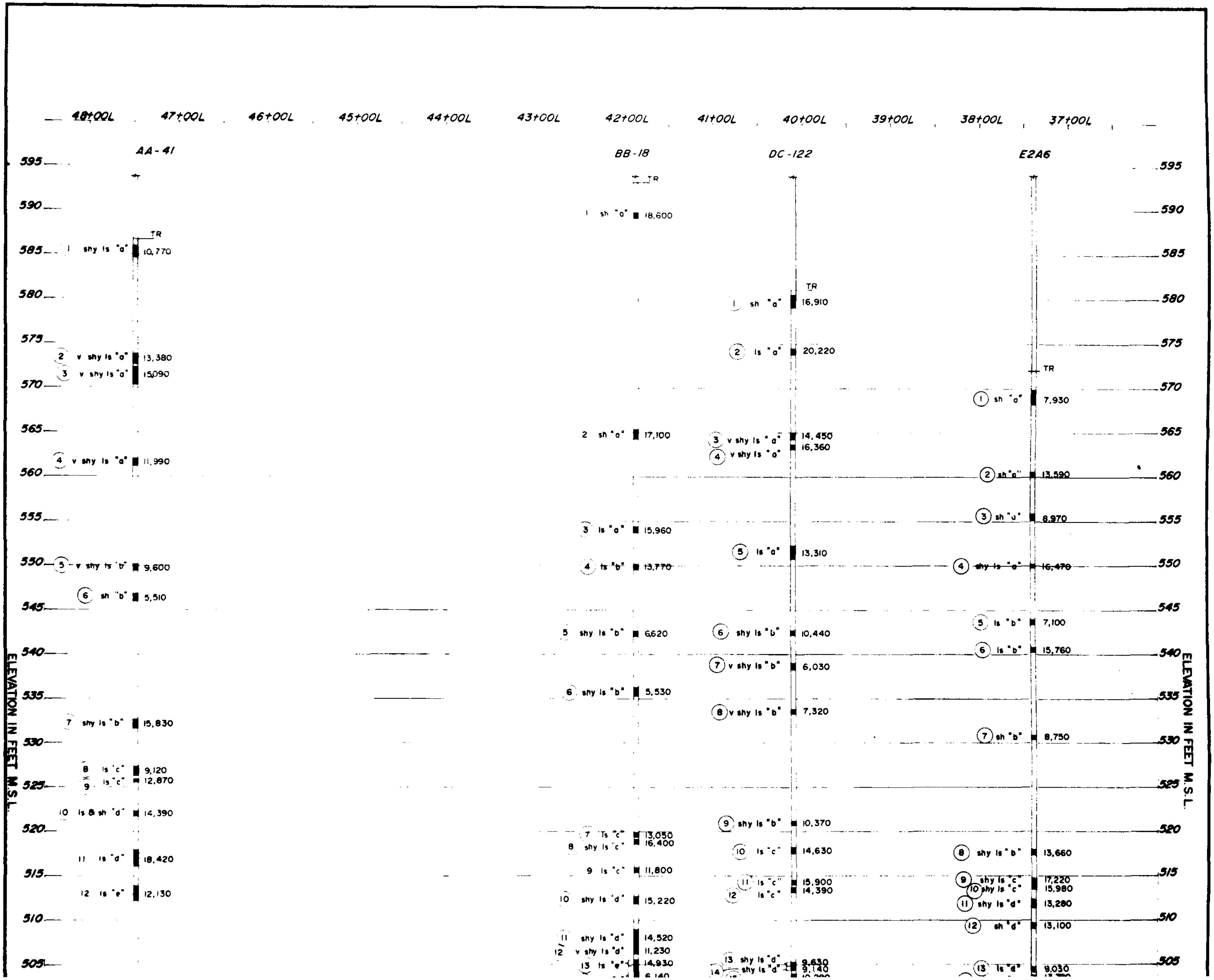
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

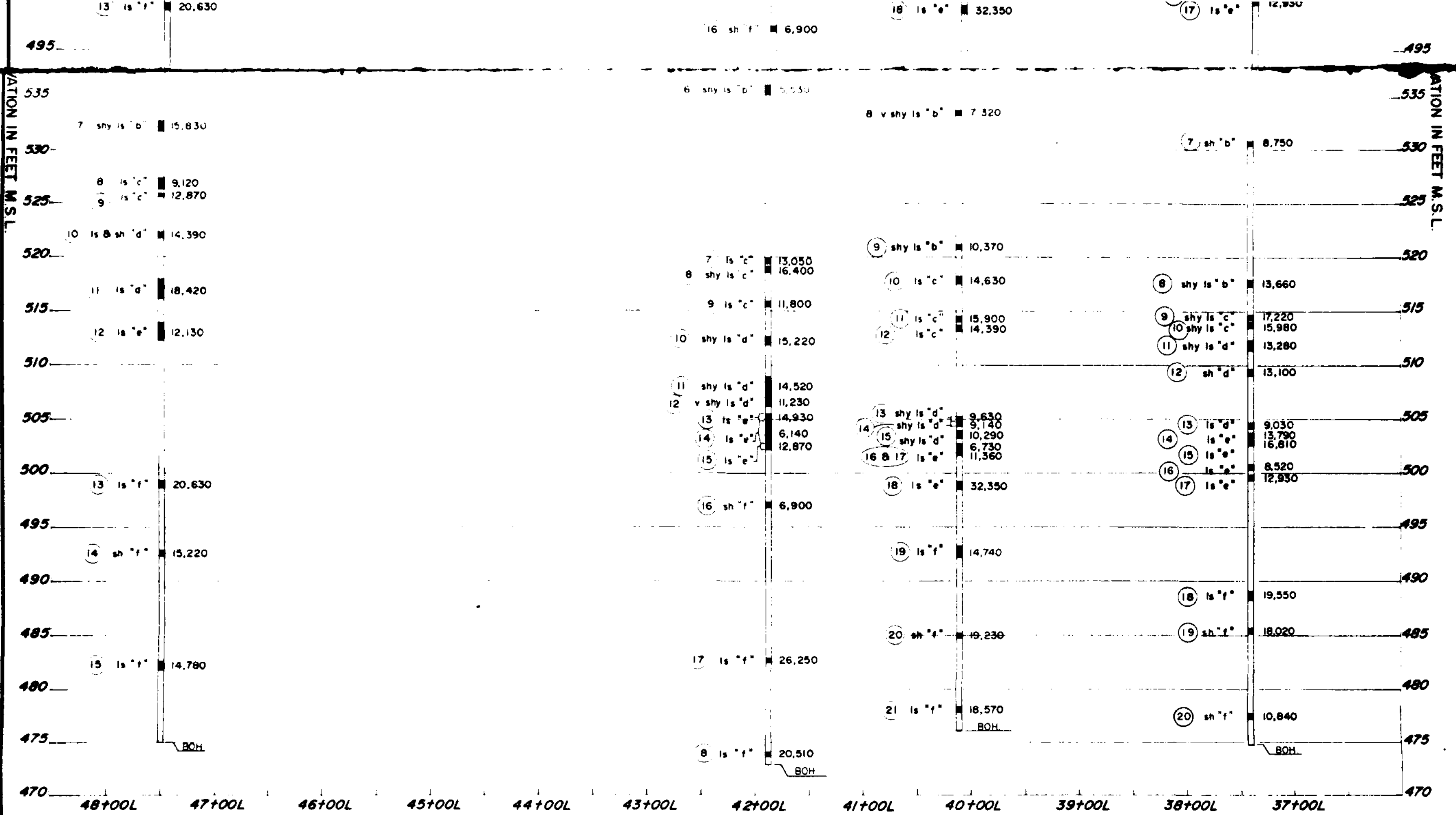
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
FOUNDATION EXPLORATION - PHASE III
STA 56+50L to 59+00L
GEOLOGIC SECTION

SCALE 1" = 10'

Q2-52/267

PLATE A-54 Q2-52/267


48+00L
47+00L
46+00L
45+00L
44+00L
43+00L
42+00L
41+00L
40+00L
39+00L
38+00L
37+00L
AA-41
BB-18
DC-122
E2A6
ELEVATION IN FEET M.S.L.
595
590
585
580
575
570
565
560
555
550
545
540
535
530
525
520
515
510
505
TR
1 shy ls "a" 10,770
2 v shy ls "a" 13,380
3 v shy ls "a" 15,090
4 v shy ls "a" 11,990
5 v shy ls "b" 9,600
6 sh "b" 5,510
7 shy ls "b" 15,830
8 ls "c" 9,120
9 ls "c" 12,870
10 ls & sh "d" 14,390
11 ls "d" 18,420
12 ls "e" 12,130
1 sh "a" 18,600
2 sh "a" 17,100
3 ls "a" 15,960
4 ls "b" 13,770
5 shy ls "b" 6,620
6 shy ls "b" 5,530
7 ls "c" 13,050
8 shy ls "c" 16,400
9 ls "c" 11,800
10 shy ls "d" 15,220
11 shy ls "d" 14,520
12 v shy ls "d" 11,230
13 ls "e" 14,930
6,140
1 sh "a" 16,910
2 ls "a" 20,220
3 v shy ls "a" 14,450
4 v shy ls "a" 16,360
5 ls "a" 13,310
6 shy ls "b" 10,440
7 v shy ls "b" 6,030
8 v shy ls "b" 7,320
9 shy ls "b" 10,370
10 ls "c" 14,630
11 ls "c" 15,900
12 ls "c" 14,390
13 shy ls "d" 9,630
14 shy ls "d" 9,140
1 sh "a" 7,930
2 sh "a" 13,590
3 sh "a" 8,970
4 shy ls "a" 16,470
5 ls "b" 7,100
6 ls "b" 15,760
7 sh "b" 8,750
8 shy ls "b" 13,660
9 shy ls "c" 17,220
10 shy ls "c" 15,980
11 shy ls "d" 13,280
12 sh "d" 13,100
13 ls "d" 9,030



UNCONFINED COMPRESSIVE STRENGTHS

SCALE 1" = 5' VERT 1" = 50 HORIZ

LEGEND

TOP OF ROCK — TR

SAMPLE NO — (2)

GENERAL GEOLOGIC DESCRIPTION — shy ls

GEOLOGIC MEMBER — "d"

ROCK SAMPLE

COMPRESSIVE STRENGTH (P.S.I.) — 11,300

BOTTOM OF HOLE — BOH

ABBREVIATIONS

sh	shale
shy	shaly
ls	limestone
v	very

NOTES

1. *For location of hole AA-41 See Dwg Q2-52/260*
2. *Holes E2A6, DC-122, and BB-18 are not within the limits of this contract and are shown for information only*
3. *All compressive strengths are unconfined*
4. *For detailed geologic logs for holes shown See Volume II Plans and Specifications*
5. *All elevations refer to Mean Sea Level, Sandy Hook Datum*

REVISION	DATE	DESCRIPTION	BY	CHKD

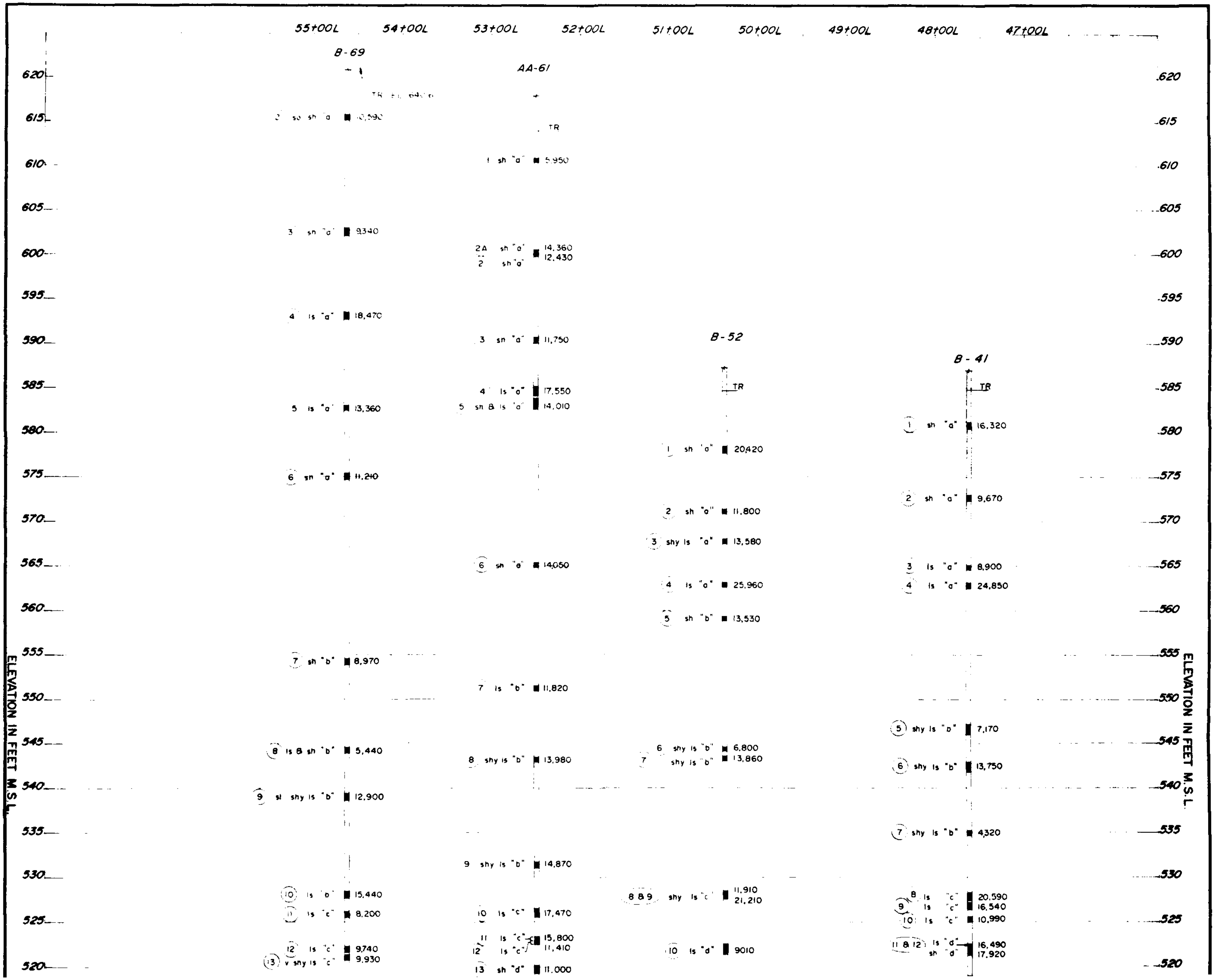
GRAPHIC SCALE

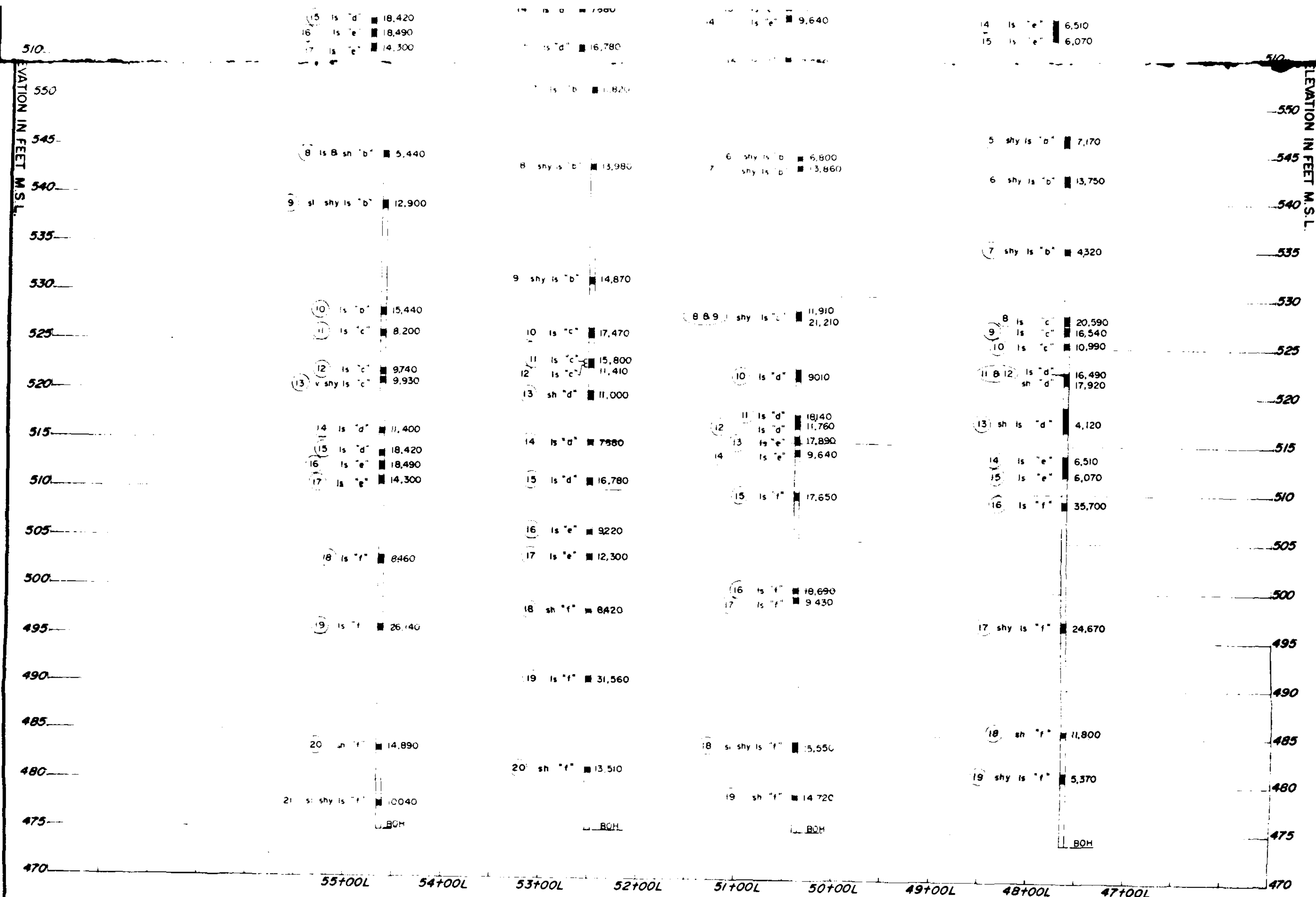
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
DIAPHRAGM WALL – AXIS ALIGNMENT
UNCONFINED COMPRESSIVE STRENGTHS – ROCK CORE

DRAWN
CHECKED
TRACED
COMPARED
SUBMITTED
CH. OF FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
SCALE AS SHOWN SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/268

7 MAY 1981


55+00L
54+00L
53+00L
52+00L
51+00L
50+00L
49+00L
48+00L
47+00L
B-69
AA-61
B-52
B-41
TR
ELEVATION IN FEET M.S.L.
620
615
610
605
600
595
590
585
580
575
570
565
560
555
550
545
540
535
530
525
520



UNCONFINED COMPRESSIVE STRENGTHS

SCALE 1" = 5' VERT. 1" = 50' HORIZ.

LEGEND

TOP OF ROCK	TR
SAMPLE NO	(2)
GENERAL GEOLOGIC DESCRIPTION	shy ls
GEOLOGIC MEMBER	"a"
ROCK SAMPLE	▪ 11,300
COMPRESSIVE STRENGTH (P.S.I.)	
BOTTOM OF HOLE	BOH

ABBREVIATIONS

sl	slightly
shy	shaly
ls	limestone
so	soft
v	very
sh	shale

NOTES

1. Sample No. 1, hole B-69 was taken between elevations 635.3 and 634.6 and had a compressive strength of 9,490 P.S.I.
2. For detailed geologic logs for holes shown see Volume II Plans and Specifications.
3. All elevations refer to Mean Sea Level, Sandy Hook Datum

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS
NASHVILLE TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

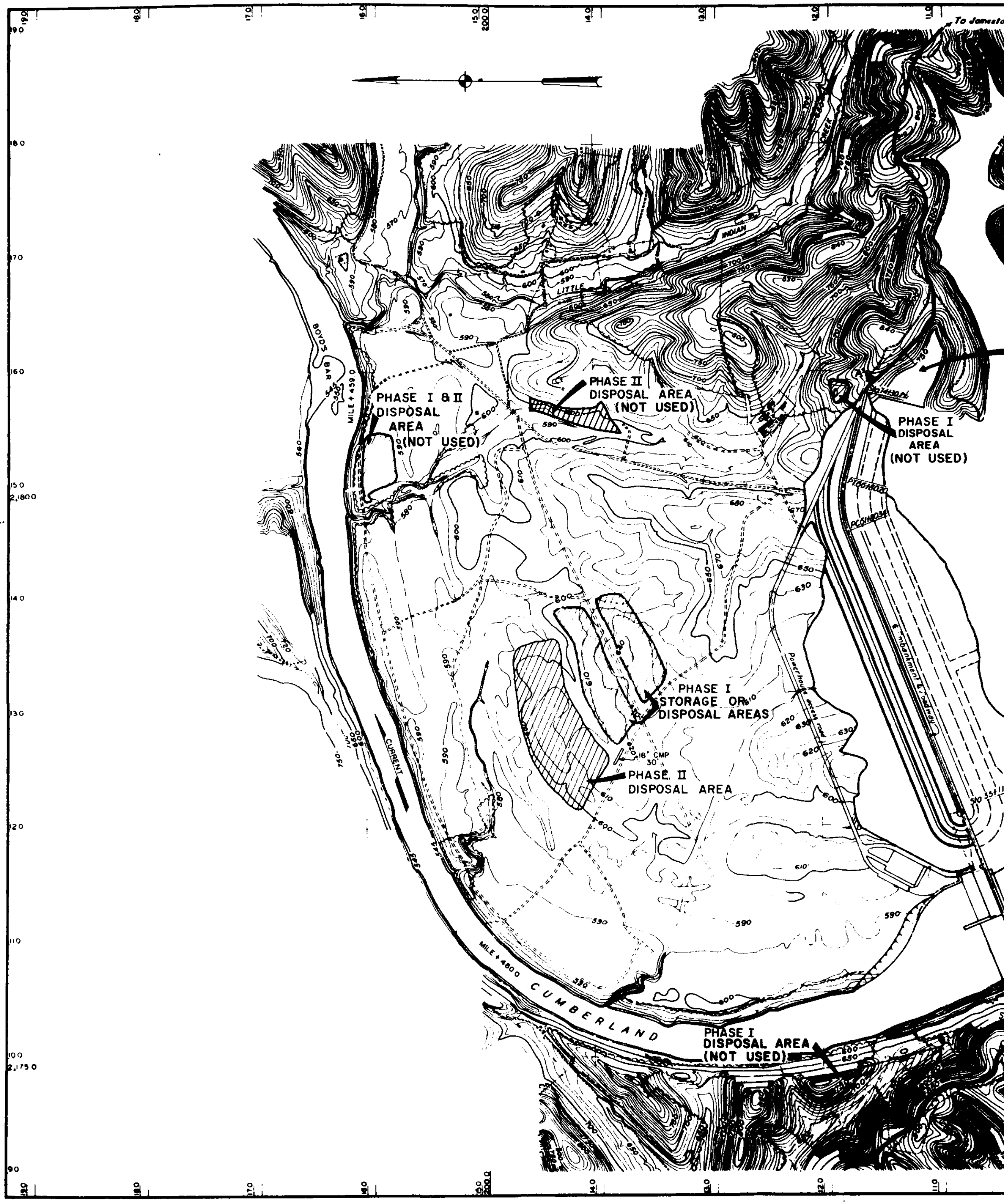
DIAPHRAGM WALL - AXIS ALIGNMENT
UNCONFINED COMPRESSIVE STRENGTHS - ROCK CORE

DRAWN | CHECKED | TRACED | COMPARED | SUBMITTED: GEOLOGIST | CHIEF, FOUNDATIONS AND MATERIALS BRANCH | APPROVED: COLONEL, C.E. DISTRICT ENGINEER | DATE

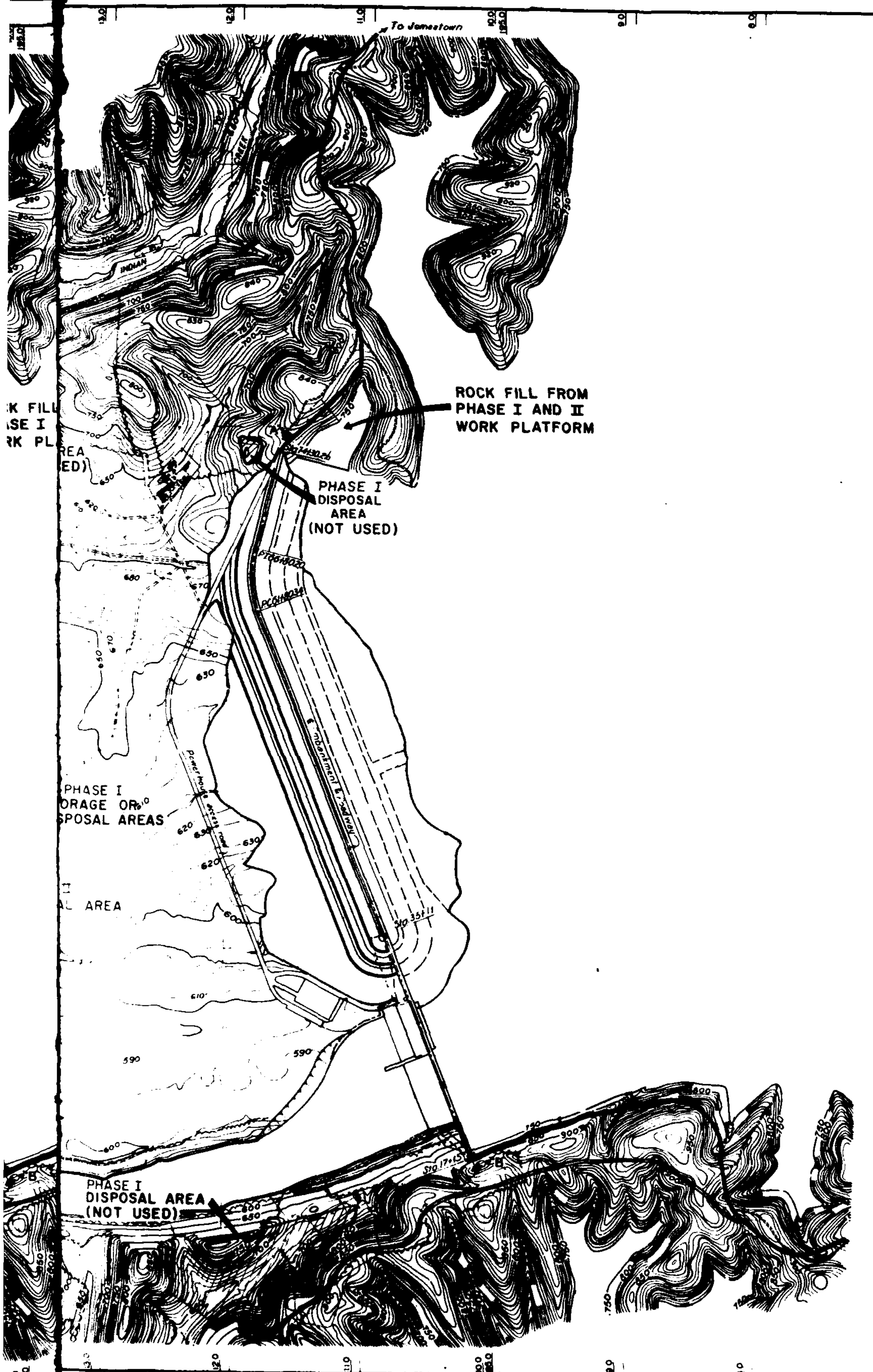
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION

SCALE AS SHOWN SPEC. NO. DRAWING NUMBER

SHEET OF Q2-52/269


PHASE I & II
DISPOSAL
AREA
(NOT USED)
PHASE II
DISPOSAL AREA
(NOT USED)
PHASE I
DISPOSAL
AREA
(NOT USED)
PHASE I
STORAGE OR
DISPOSAL AREAS
18" CMP
PHASE II
DISPOSAL AREA
PHASE I
DISPOSAL AREA
(NOT USED)
BOYDS BAR
LITTLE
INDIAN
CURRENT
CUMBERLAND
MILE + 459.0
MILE + 480.0

CORPS OF ENGINEERS, U. S. ARMY



GENERAL NOTES

GRID NUMBERS IN THOUSAND FEET
ALL ELEVATIONS ARE MEAN SEA LEVEL SANDY HOOK DATUM
CONTOUR INTERVAL 10 FEET
SURVEY CONTROLLED BY LOCAL SYSTEM OF PLANE RECTANGULAR COORDINATES

REVISION	DATE	DESCRIPTION	BY	CHKD
1	9-24-81	REVISED AS CONSTRUCTED	L L	

GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

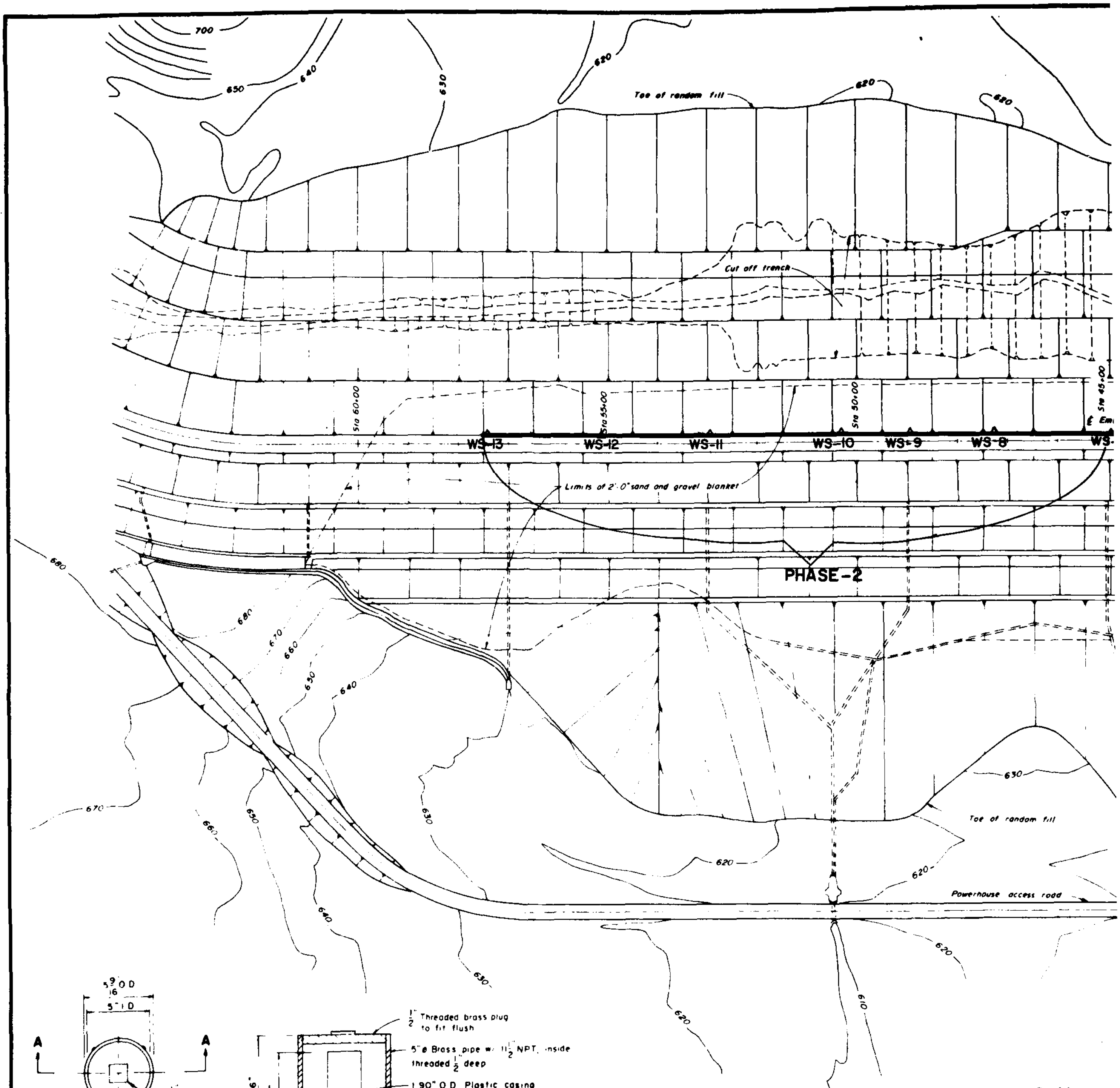
DRAWN: A G CHAPMAN
CHECKED:
TRACED:
COMPARED:
ENGINEER

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

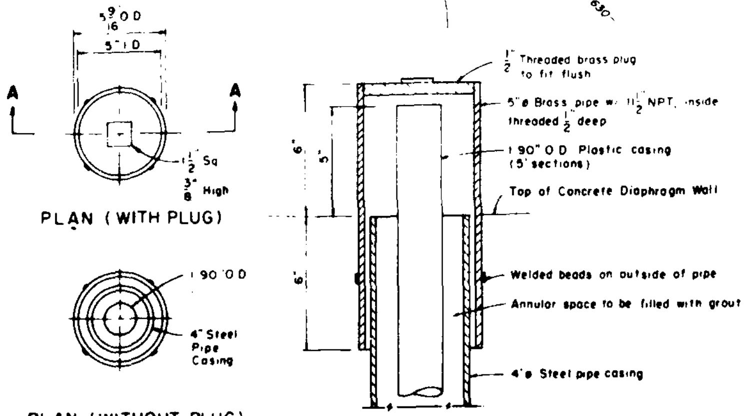
DISPOSAL AREAS

SUBMITTED: CHIEF, FOUNDATION AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C E DISTRICT ENGINEER
DATE APRIL, 1977
SCALE 1:400 SPEC NO
DRAWING NUMBER
SHEET OF
Q2-52/270.1

RECORD DRAWING AS CONSTRUCTED DATED 7 May 1981



PLAN



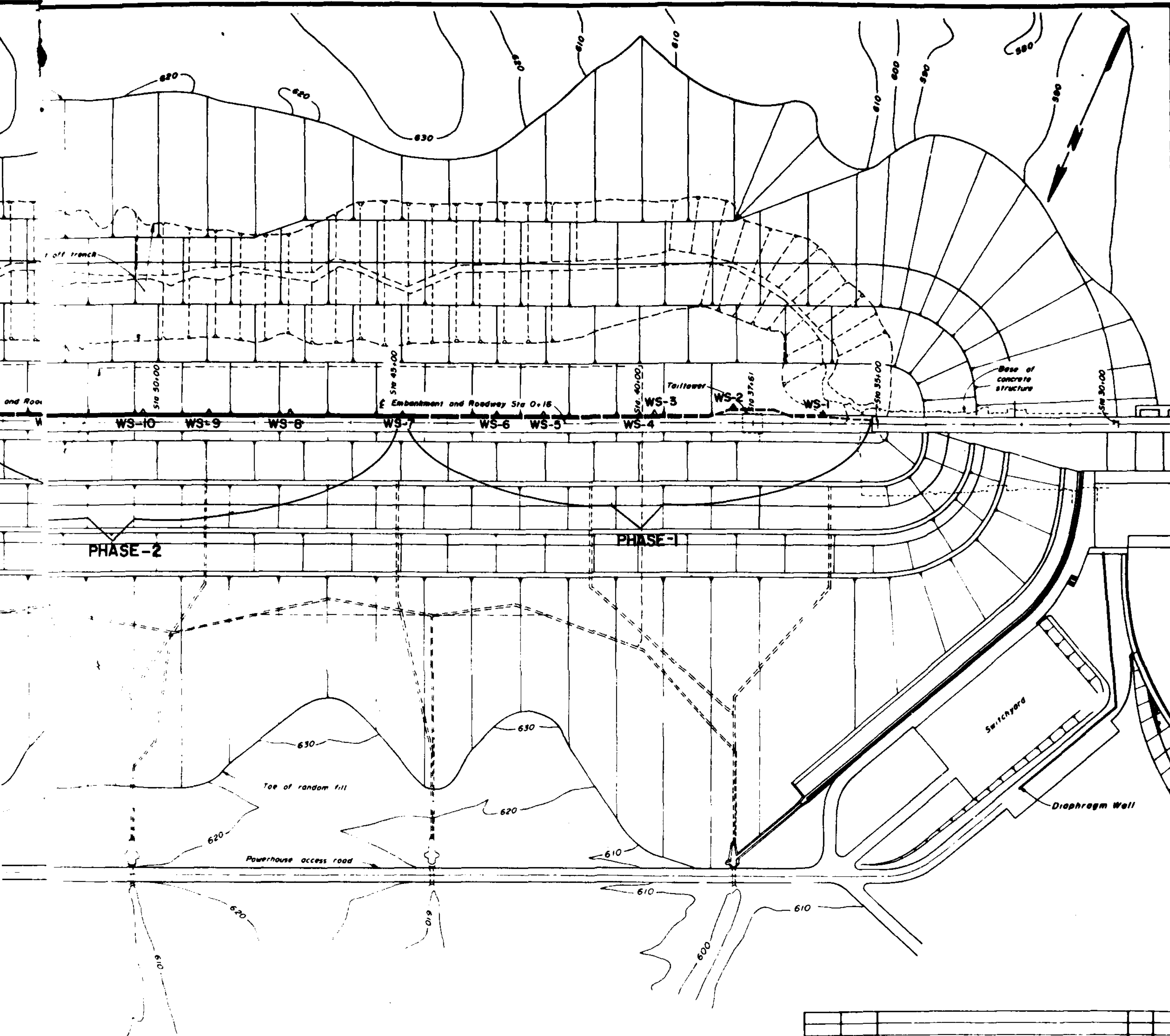
PLAN (WITH PLUG)

PLAN (WITHOUT PLUG)
SCALE 1/4" = 1"

SECTION A-A
SCALE NONE

PROTECTIVE HOUSING DETAILS

INCLINOMETER LOCATION			
INSTALLATION	COORDINATES		ESTIMATED DEPTH OF INSTRUMENT
	"L" STATION	"A" & "B" STATION	
WS-8	47+26	0+00AB	213.0 FT
WS-9	48+97	0+00AB	213.0 FT
WS-10	50+32	0+00AB	213.0 FT
WS-11	52+93	0+00AB	266.0 FT
WS-12	55+13	0+00AB	172.0 FT
WS-13	57+43	0+00AB	172.0 FT



PLAN

NOMETER LOCATION		
RDINATES		ESTIMATED DEPTH
ION	"A" "B" "B" STATION	OF INSTRUMENT
26	0 + 00 AB	213.0 FT
17	0 + 00 AB	213.0 FT
12	0 + 00 AB	213.0 FT
13	0 + 00 AB	256.0 FT
3	0 + 00 AB	172.0 FT
43	0 + 00 AB	172.0 FT

.1	9-24-81	REVISED AS CONSTRUCTED	L.L.	

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

C.R.E. III

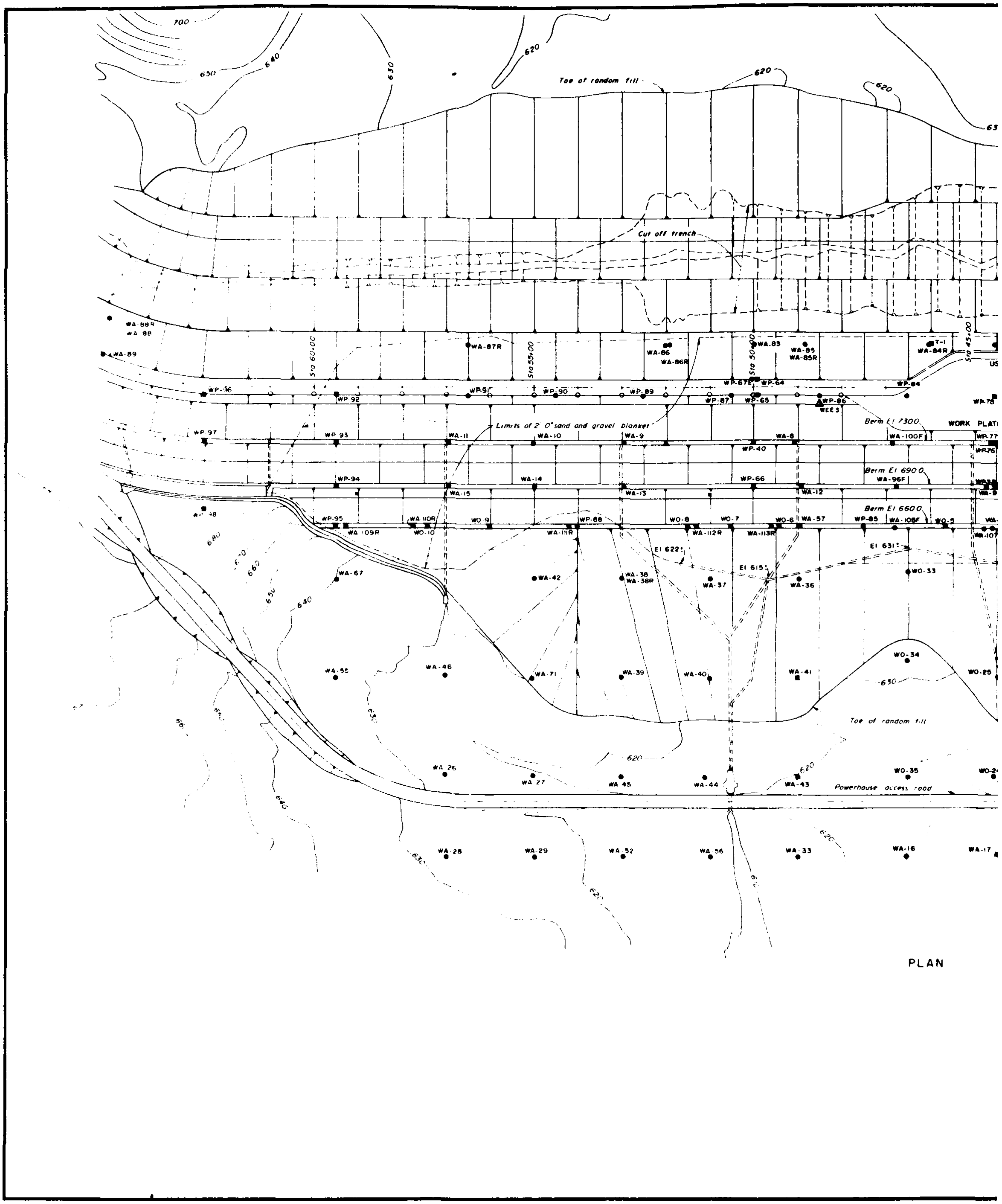
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION
PLAN

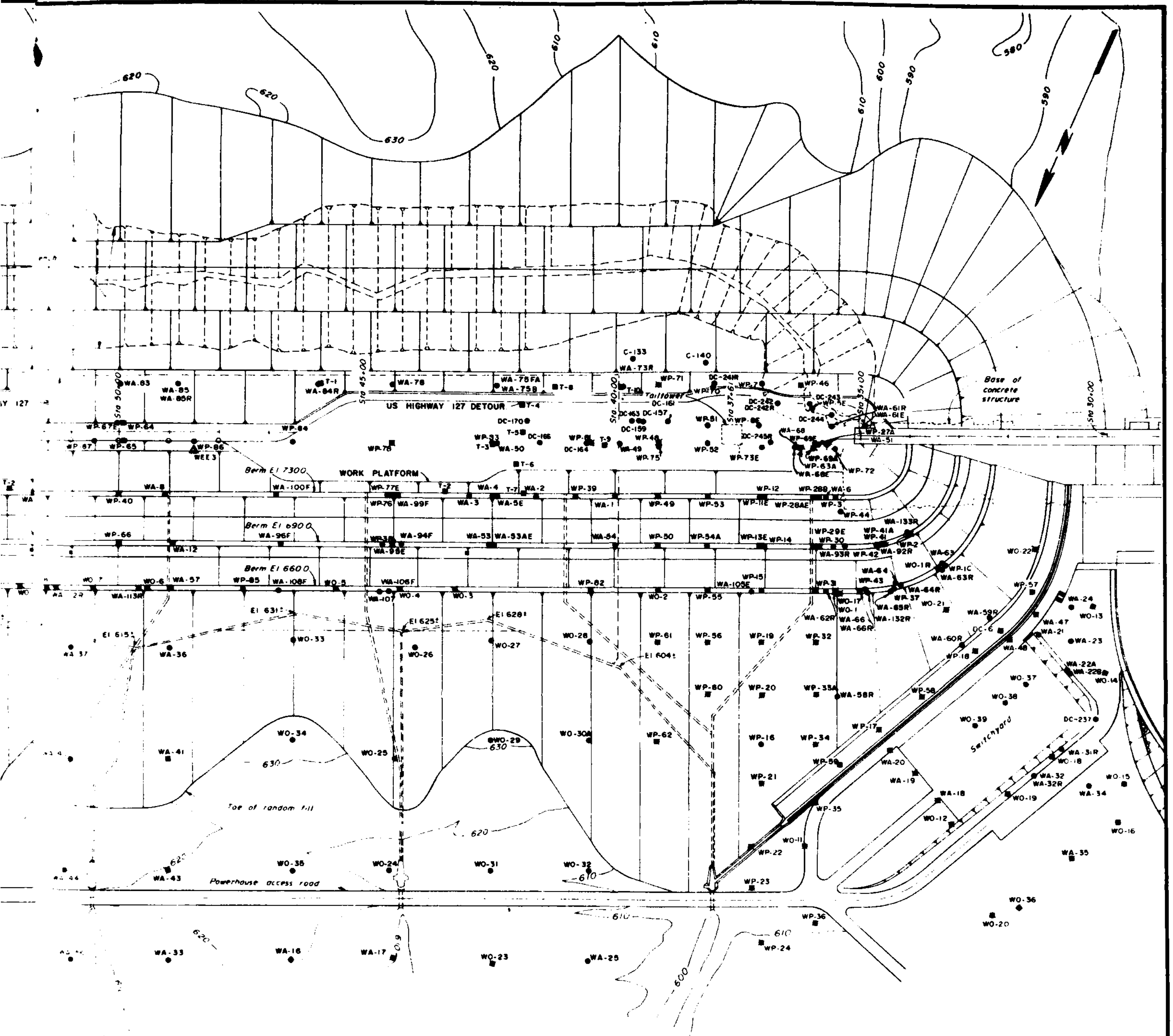
SCALE 1" = 100'

DATE APRIL 1975

02-52/271.1

PLATE A-58


Toe of random fill
Cut off trench
Limits of 2' 0" sand and gravel blanket
Sta 60+00
Sta 55+00
Sta 50+00
Sta 45+00
Berm El 7300
WORK PLAT
Berm El 6900
Berm El 6600
El 622±
El 615±
El 631±
Toe of random fill
Powerhouse access road
PLAN



PLAN

LEGEND:

- *WA-33E - Embankment Piezometer*
- *WA-33F - Filter Piezometer*
- *WA-33 - Top of Rock Piezometer*
- *WA-33R - Bedrock Piezometer*
- ● *Existing Piezometer*
- ○ *Surface Movement Monument*
- ▲ *Siesmic Instrumentation*
- ■ *Transducer*

REVISION	DATE	DESCRIPTION	BY	CHKD.

100' 0 100' 200'

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN AGC
CHECKED A D
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

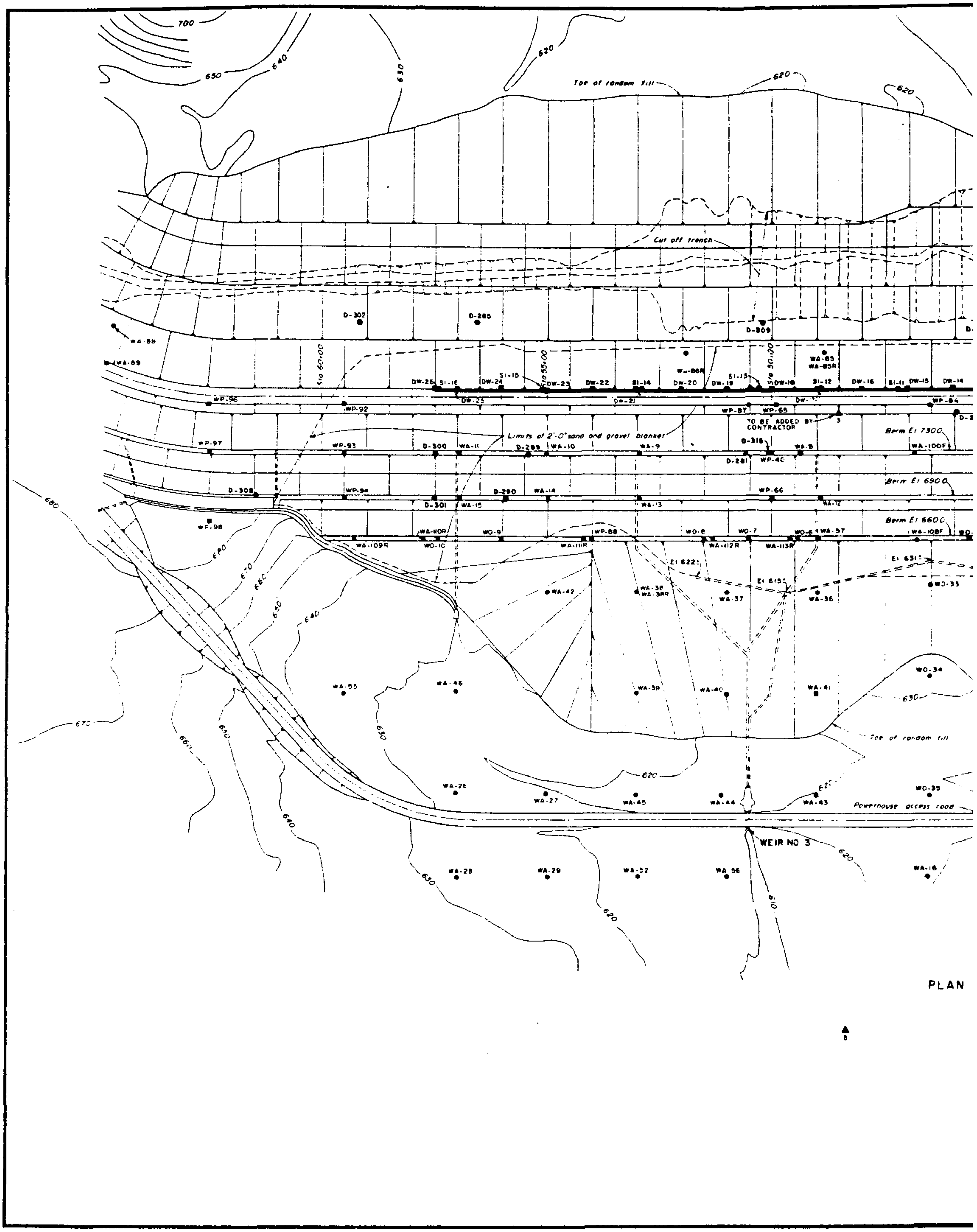
EXISTING INSTRUMENTATION AND MONUMENTATION PLAN

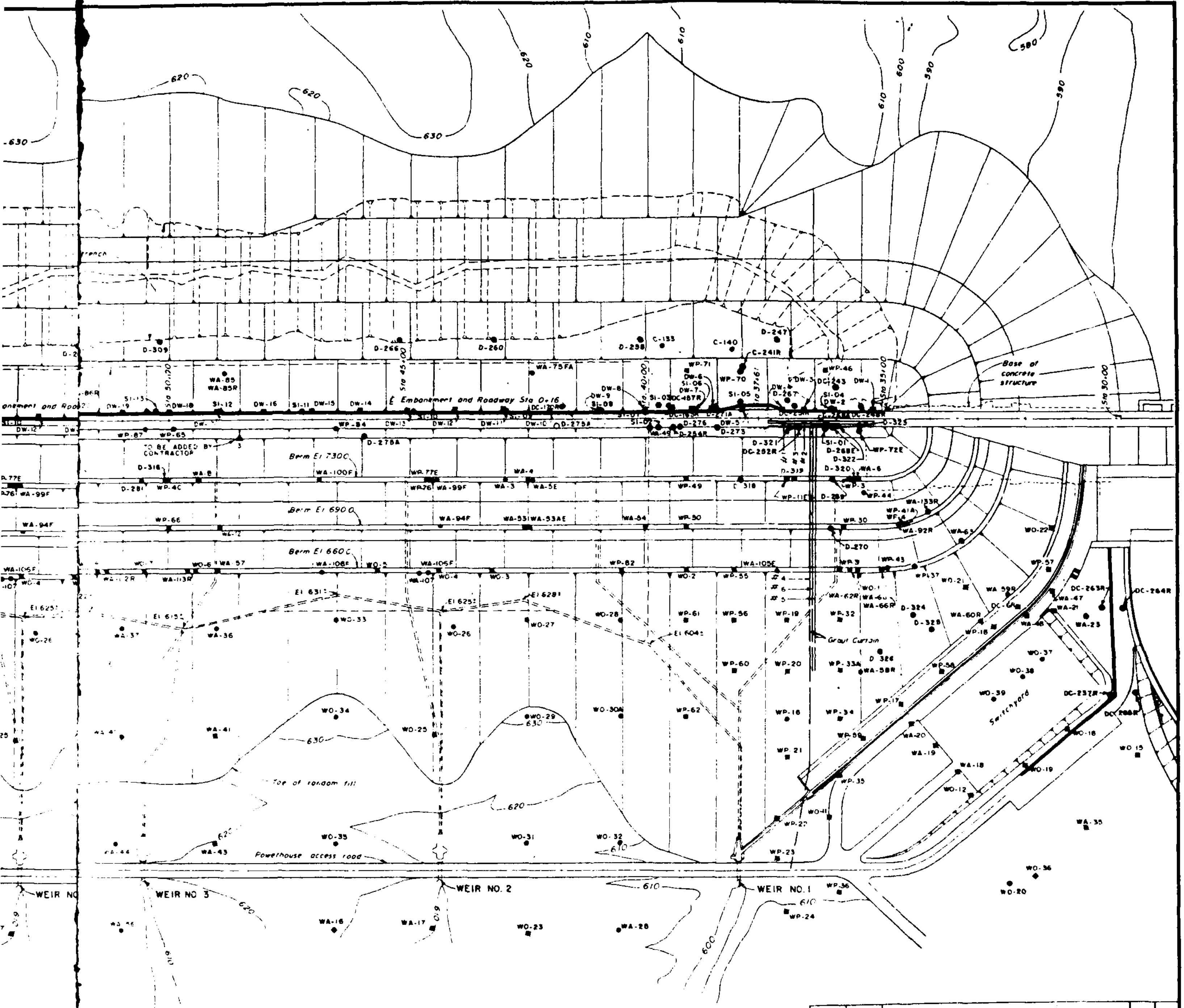
SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
SCALE: 1" = 100'
DATE APRIL 1977
SHEET OF
02-52/272

PLATE A-59

APPENDIX B

INSTRUMENTATION PLOTS


Toe of random fill
Cut off trench
Limits of 2'-0" sand and gravel blanket
TO BE ADDED BY CONTRACTOR
Berm El 730.0
Berm El 690.0
Berm El 660.0
Sta 60+00
Sta 55+00
Sta 50+00
D-302
D-285
D-309
WA-88
WA-89
WP-96
WP-92
WP-97
WP-93
D-300
WA-11
WA-10
WA-9
D-308
WP-94
D-290
WA-14
D-301
WA-15
WP-66
WP-98
WA-109R
WO-9
WP-88
WA-111R
WO-8
WO-7
WA-112R
WA-113R
WA-57
WA-108F
El 622±
El 615±
WA-42
WA-37
WA-36
WO-33
WA-55
WA-46
WA-39
WA-41
WO-34
WA-26
WA-27
WA-45
WA-44
WA-43
WO-35
Powerhouse access road
WEIR NO 3
WA-28
WA-29
WA-56
WA-16
PLAN



PLAN

LEGEND

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- SI-03 - Inclinometer
- ■ Monumentation
- ▲ Seismic Instrument

REVISION	DATE	DESCRIPTION	BY	CHKD
3	8-29-88	Relocated SI-06 & SI-04	EPD	WCF
2	3-15-83	REVISED AS CONSTRUCTED	CNO	
1	3-31-82	Added Piezometers	mor	

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

INSTRUMENTATION PLAN

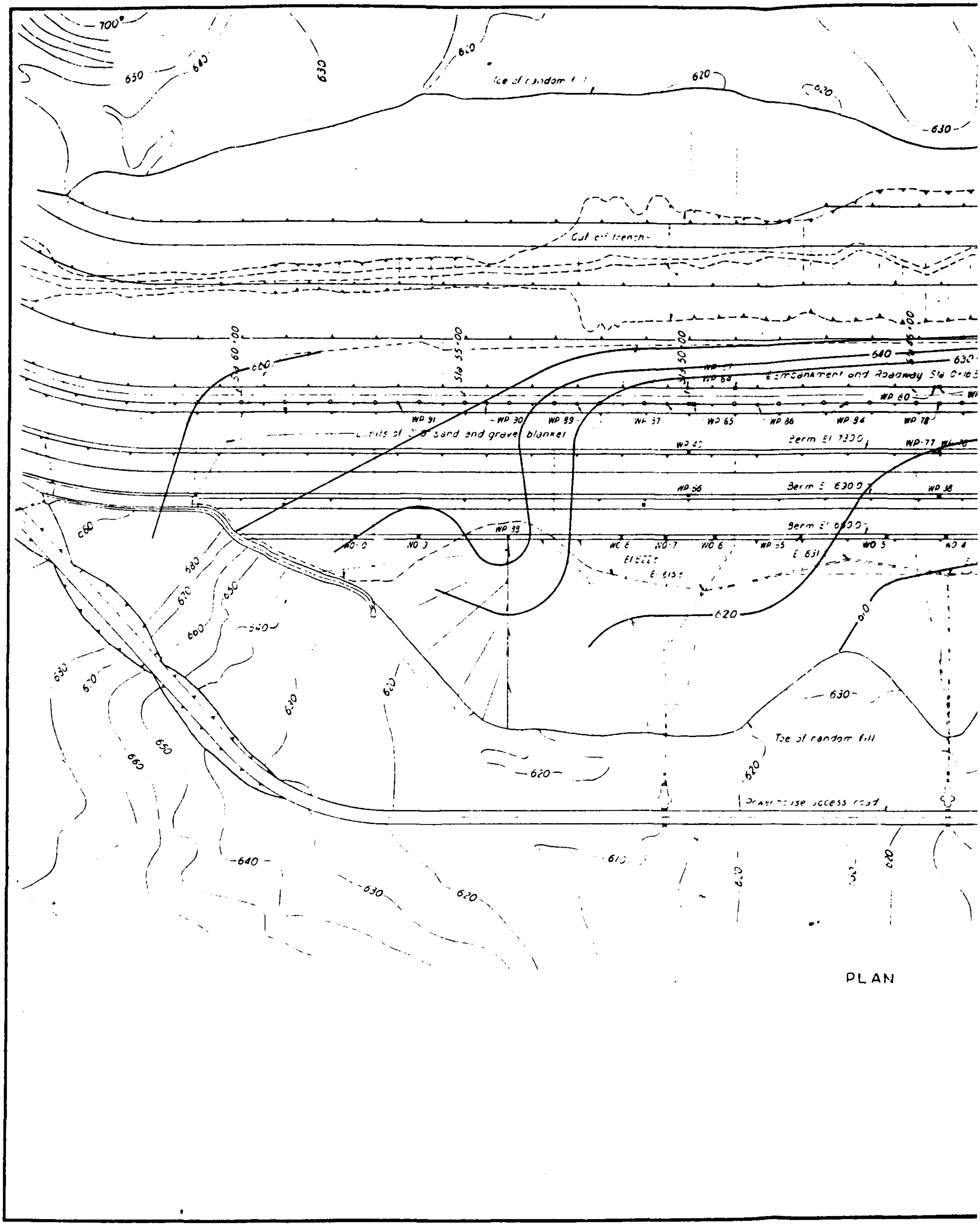
CHIEF, GEOTECHNICAL BRANCH

COLONEL, C.E. DISTRICT ENGINEER

SCALE 1" = 100'

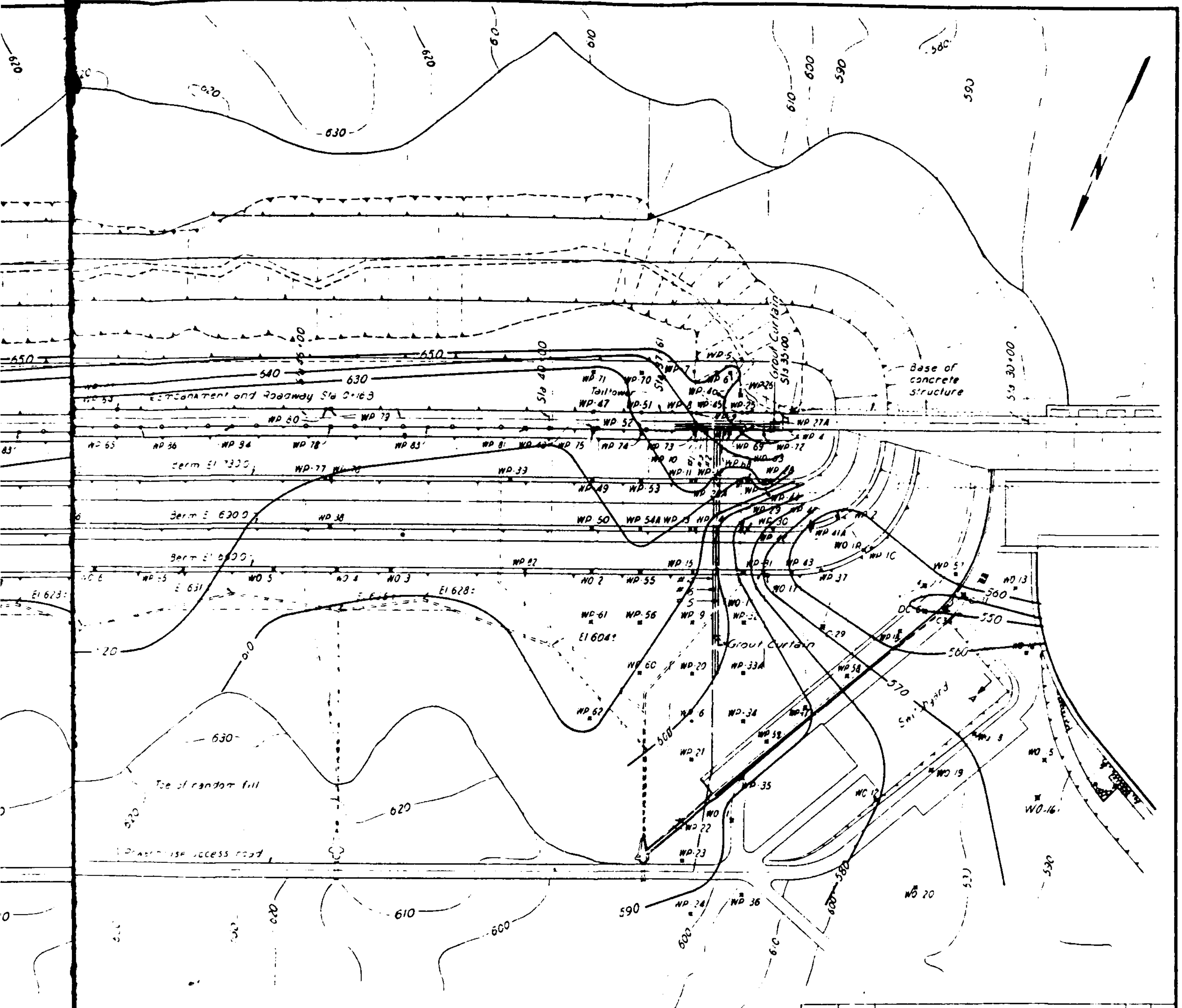
Q2-52/295.3

PLATE B- 1



Cut off trench
Toe of random fill
Berm El 630.0
WP 91
WP 30
WP 65
WP 86
WP 84
WP 78
WP 80
WP 56
WP 99
WO 3
WO 5
640
630
620
660
680
700

PLAN



PLAN

LEGEND

- • Casagrande Piezometer
- ▪ Well Point Piezometer
- ○ Surface Settlement Monument
- ● Existing Settlement Gage

GENERAL NOTES

1 Water level contours are based on piezometer readings made 20 & 21 Jan 1969 at 0800 hrs. Headwater and tailwater elevations at the same time are El 692.71 and El 542.31 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

100' 0 100' 200'
GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

DRAWN BRC & DJ
CHECKED BRC
TRACED
COMPARED

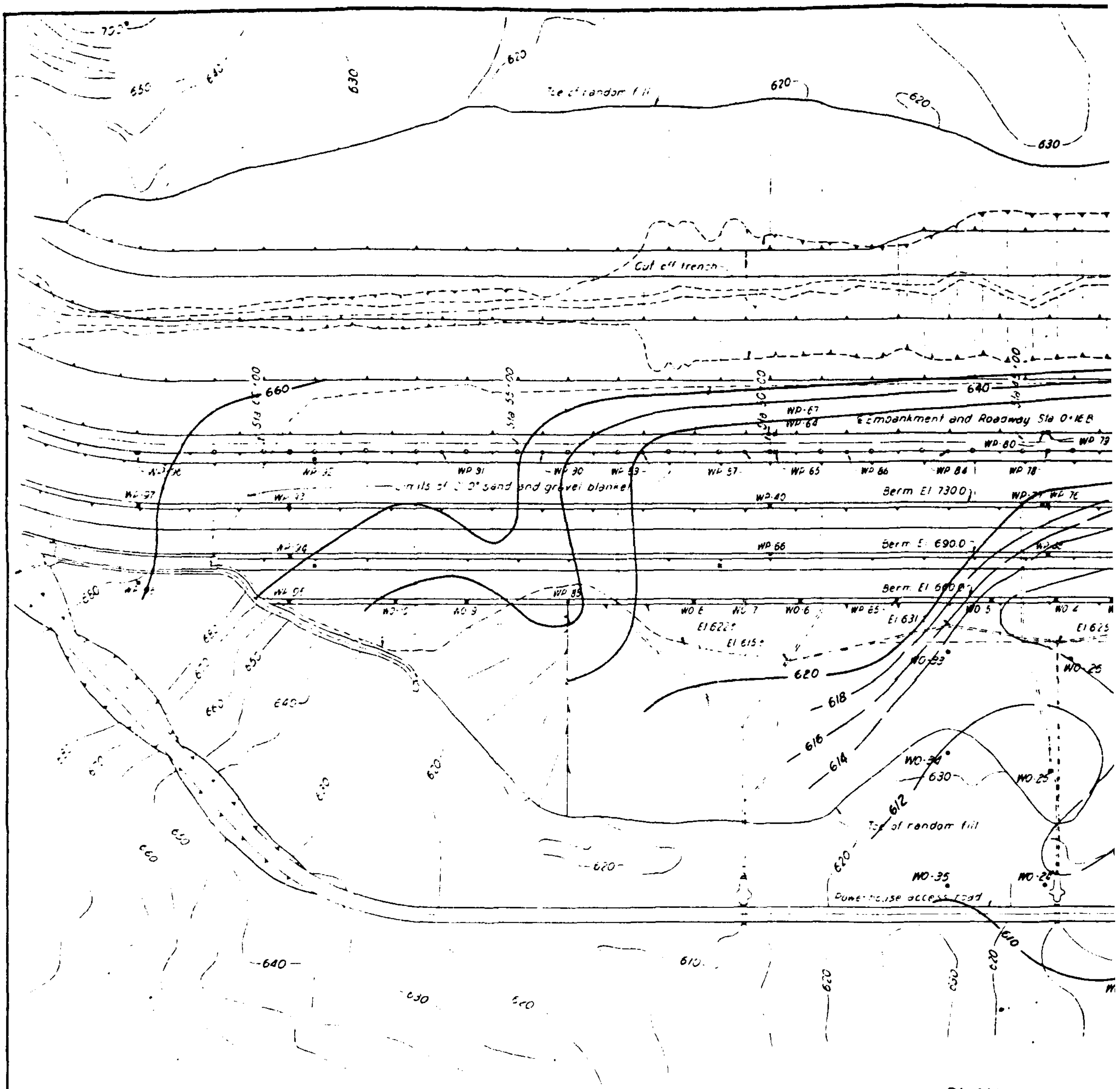
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 20 & 21 JAN AT 0800 HRS

SUBMITTED
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E DISTRICT ENGINEER

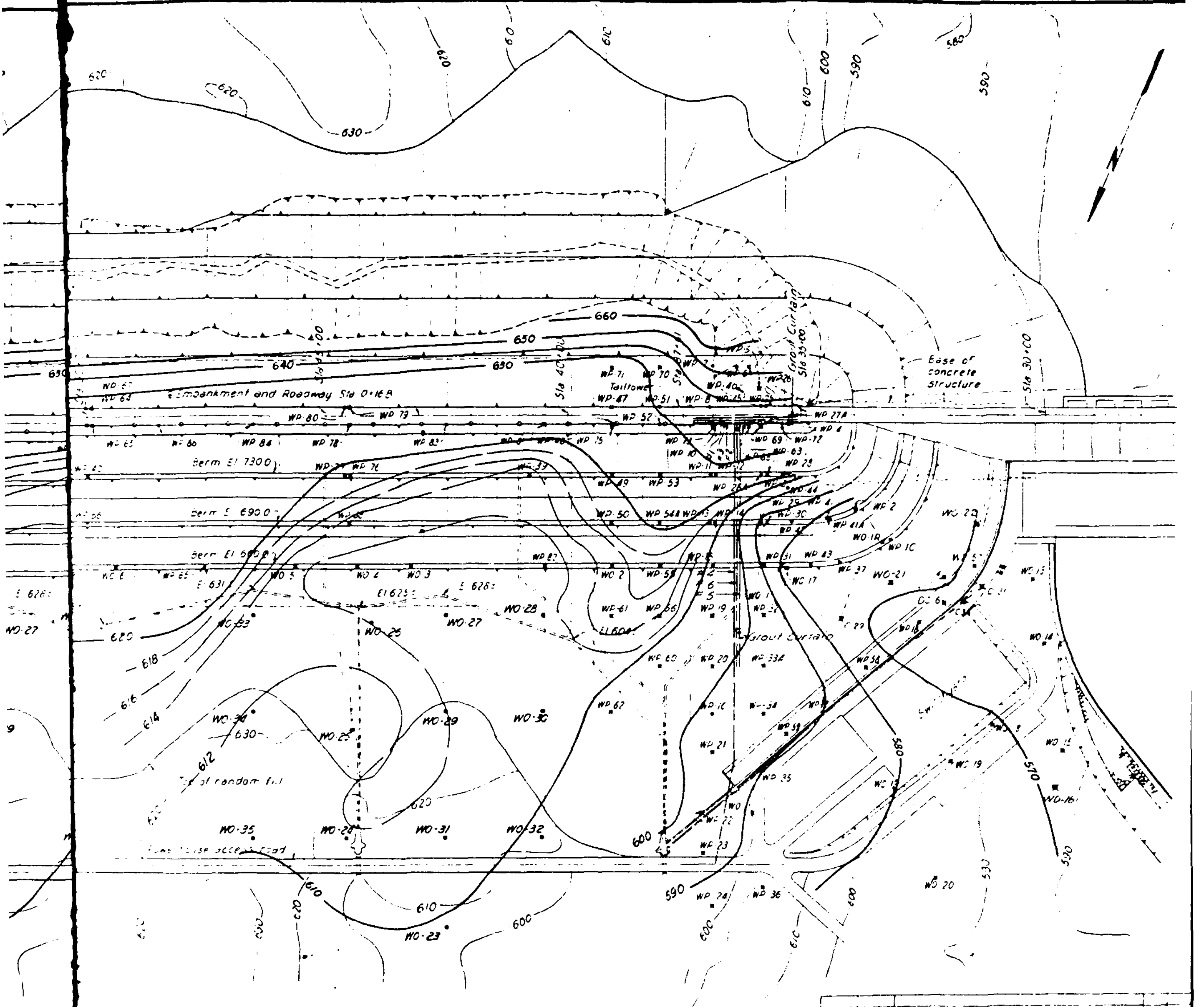
DATE OCTOBER 1973

02-5/26

PLATE B- 2


Toe of random fill
Cut off trench
Embankment and Roadway Sta 0+18 B
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Toe of random fill
Powerhouse access road
620
630
640
660
618
616
614
612
610

PLAN



LEGEND

- Casagrande Piezometer
- Well Point Piezometer
- Surface Settlement Monument
- Existing Settlement Gage

GENERAL NOTES

Water level contours are based on piezometer readings made 10 & 11 Feb 1970 @ 1300 hrs. Headwater and Tailwater elevations on 10 Feb are El 703.63 and El 550.80 respectively

REVISION	DATE	DESCRIPTION	BY	CHKD

100 0 100 200
GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

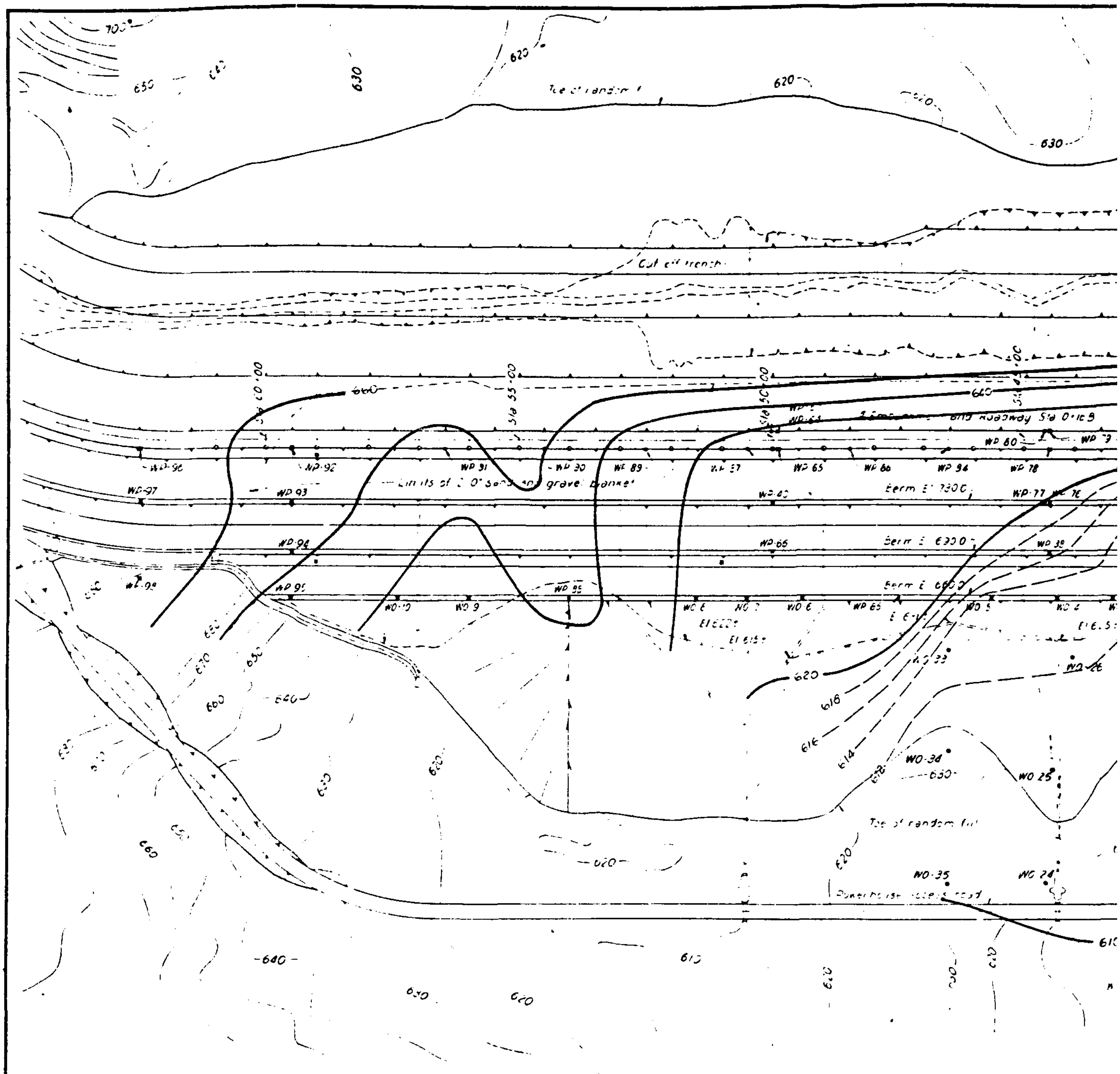
DRAWN BRC & DJ
CHECKED BRC
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 10&11 FEB AT 1300 HRS

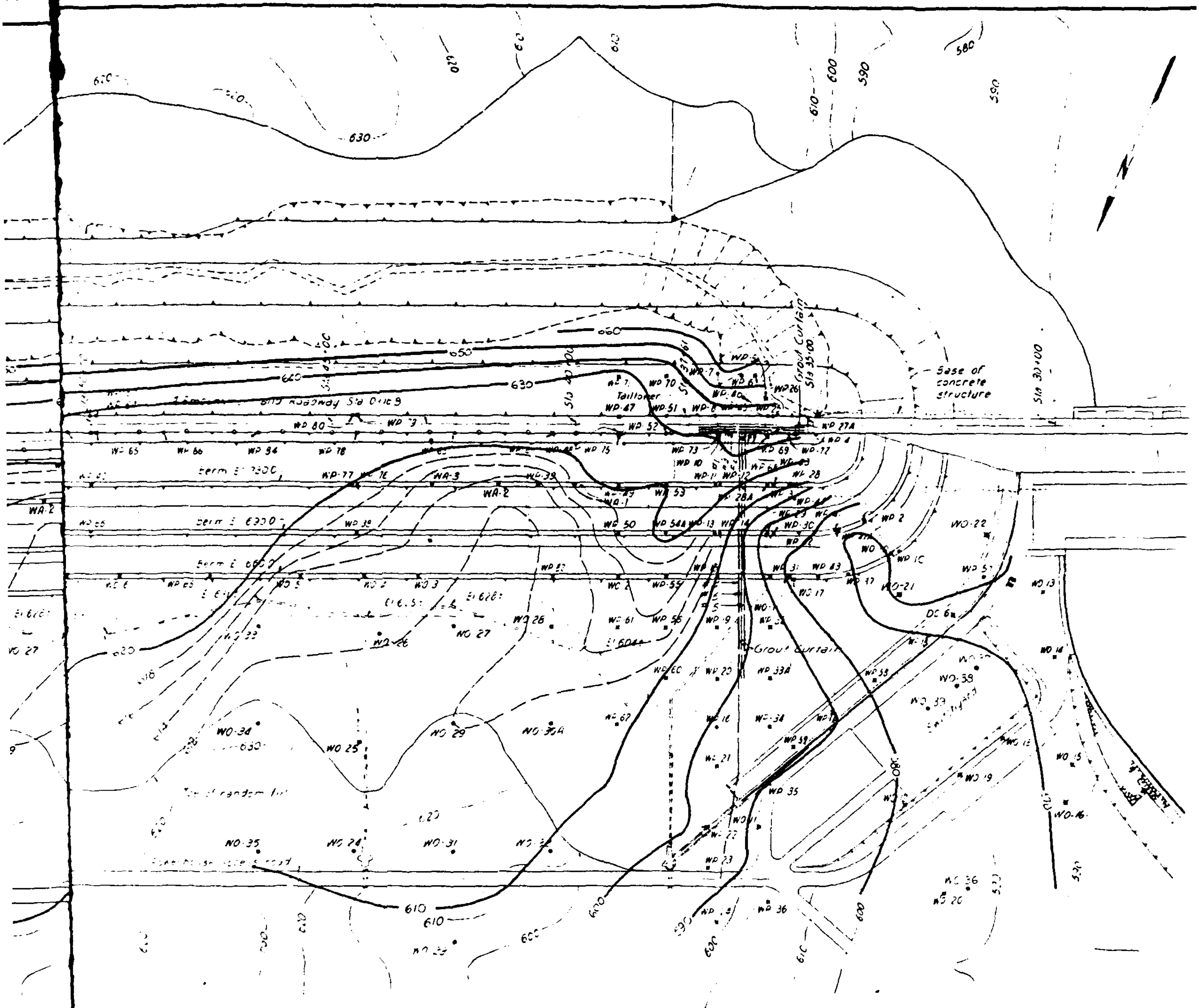
SUBMITTED
APPROVAL RECOMMENDED
ACTING CHIEF FOUNDATION AND MATERIALS BRANCH
CHIEF, ENGINEERING DIVISION
APPROVED
SCALE 1" = 100'
COLONEL, C. E. DISTRICT ENGINEER

DATE OCTOBER 1973

PLATE B-3


Toe of random fill
Cut off trench
Limits of 2.0' sand and gravel blanket
Berm El 630.0
Toe of random fill
Powerhouse access road

PLAN



PLAN

LEGEND

- • Casagrande Piezometer
- ■ Well Point Piezometer
- Surface Settlement Monument
- ■ Existing Settlement Gage

GENERAL NOTES

1 Water level contours are based on piezometer readings made 25 November 1970. Headwater and Tailwater elevations on that day are El. 696.15 and El. 559.80 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

100 0 100 200

GRAPHIC SCALE

U.S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

DRAWN BRC & DJ
CHECKED BRC
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 25 NOVEMBER 1970

ENGINEER

SUBMITTED
ACTING CHIEF FOUNDATIONS AND MATERIALS BRANCH

APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION

APPROVED
COLONEL, C.E. DISTRICT ENGINEER

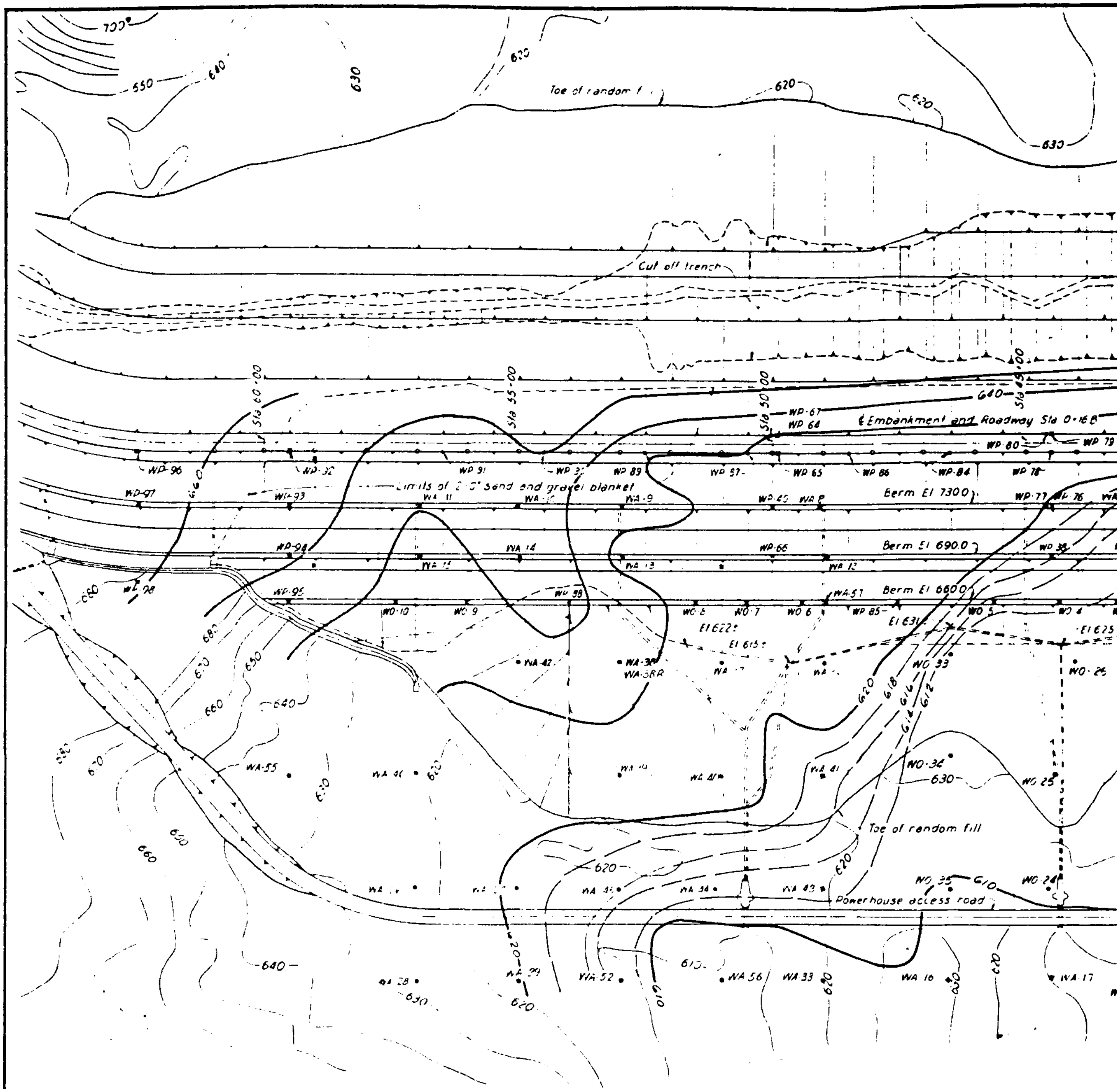
SCALE 1" = 100'

DATE OCTOBER 1973

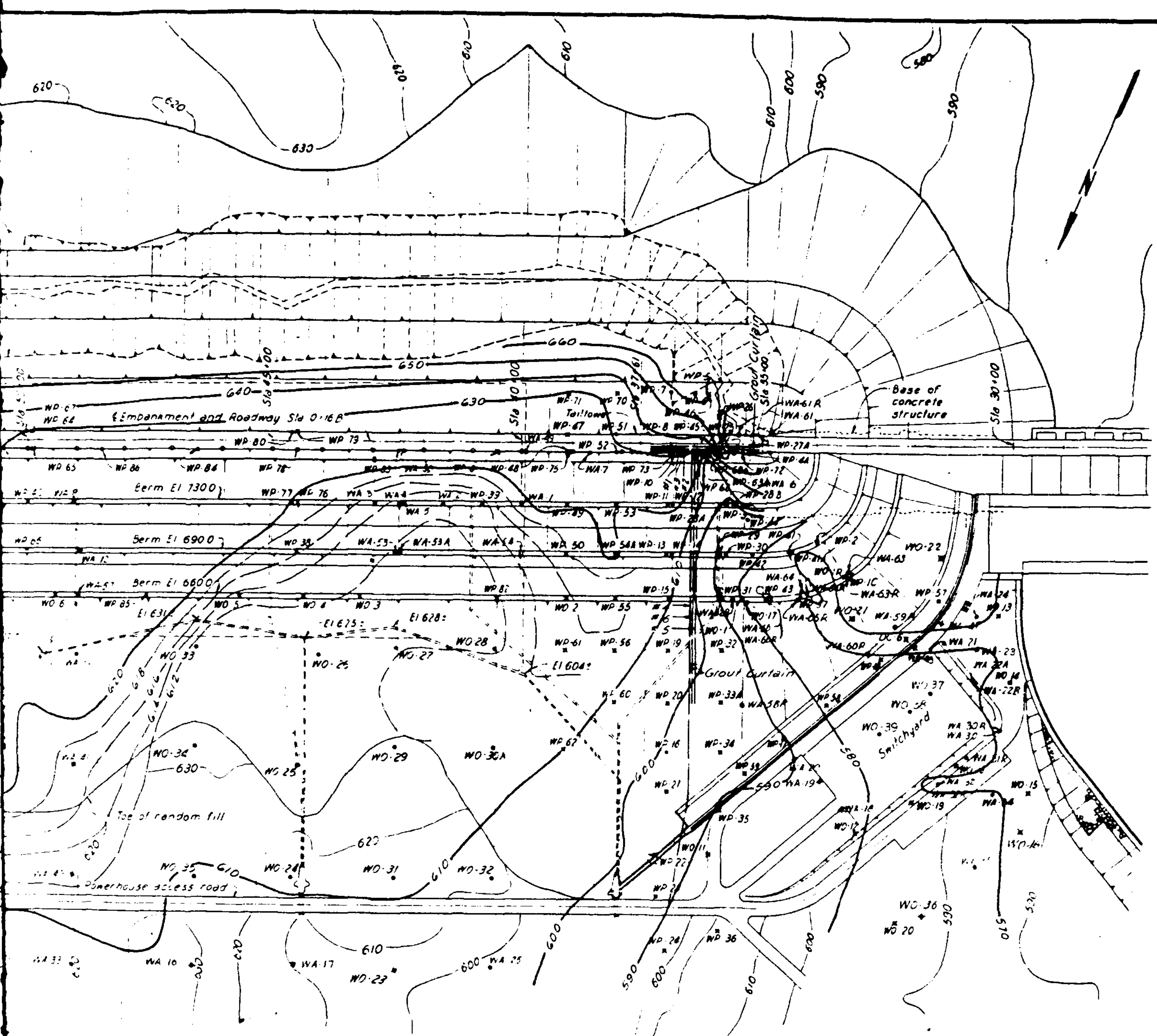
SHEET OF

02-5/57

PLATE B- 4


Toe of random fill
Cut off trench
¢ Embankment and Roadway Sta 0+16B
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Sta 60+00
Sta 55+00
Sta 50+00
Sta 45+00
El 622±
El 615±
El 631
El 625
Toe of random fill
Powerhouse access road
WP-96
WP-97
WP-93
WP-94
WP-95
WP 91
WP 89
WP 57
WP 65
WP 86
WP 84
WP 80
WP 79
WP 78
WP-77
WP 76
WP-67
WP 64
WP-66
WP 85
WA-9
WA 14
WA 13
WA 12
WA-57
WA 42
WA-30
WA-30R
WA-55
WA 41
WA 16
WA 17
WA 33
WA 56
WA-52
WA 29
WA 43
WO 10
WO 9
WO 8
WO 7
WO 6
WO 5
WO 4
WO 33
WO-34
WO 25
WO 35
WO-24
630
620
640
650
660
680
610
618
616
614
612

PLAN



PLAN

LEGEND

- • Casagrande Piezometer
- ▪ Well Point Piezometer
- ○ Surface Settlement Monument
- ■ Existing Settlement Gage

GENERAL NOTES

Water level contours are based on piezometer readings made 20 Dec. 1971. Headwater and Tailwater elevations on 20 Dec. are El. 704.2 and El. 543.3 respectively.

100' 0 100' 200'
GRAPHIC SCALE

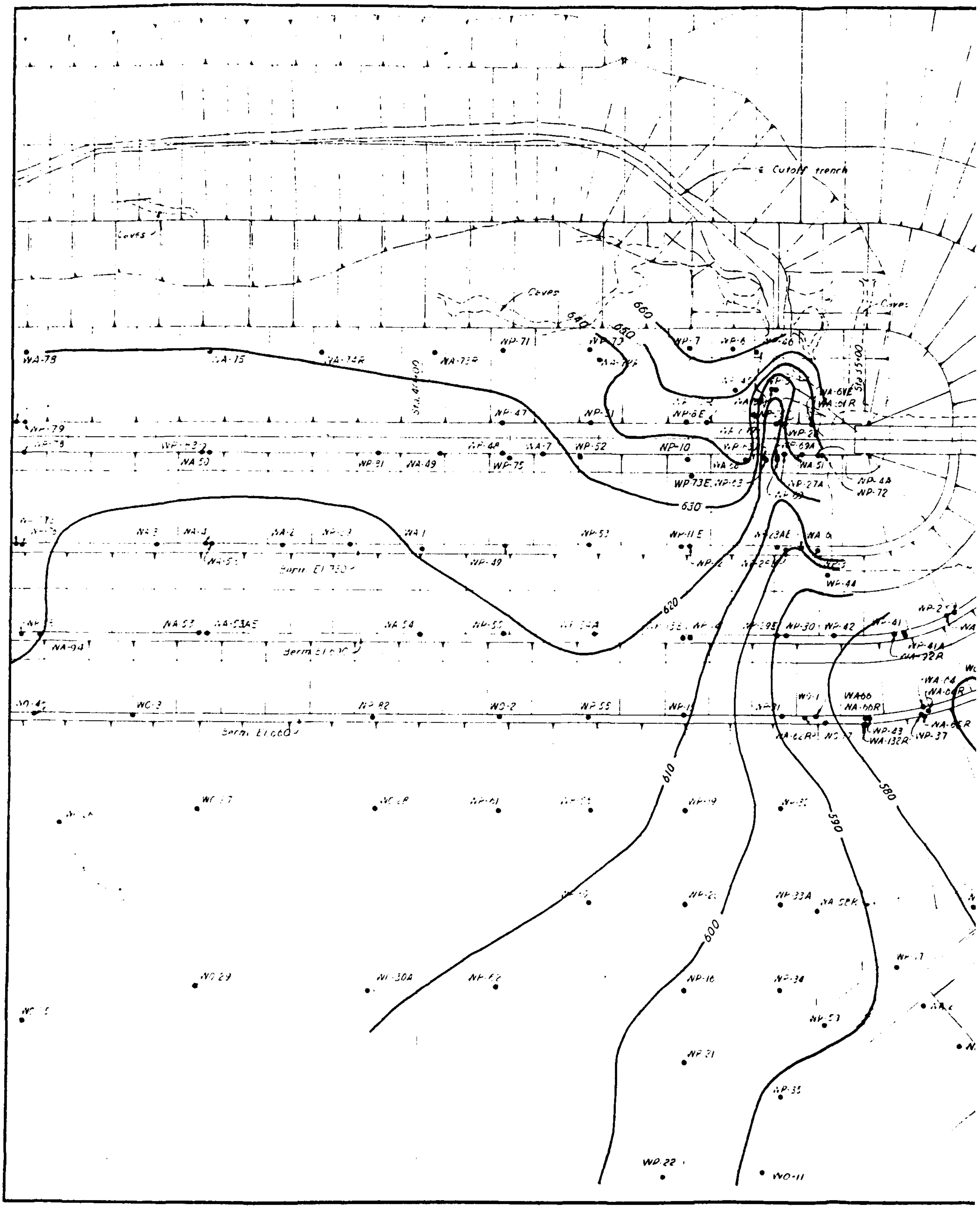
U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 20 DEC 1971

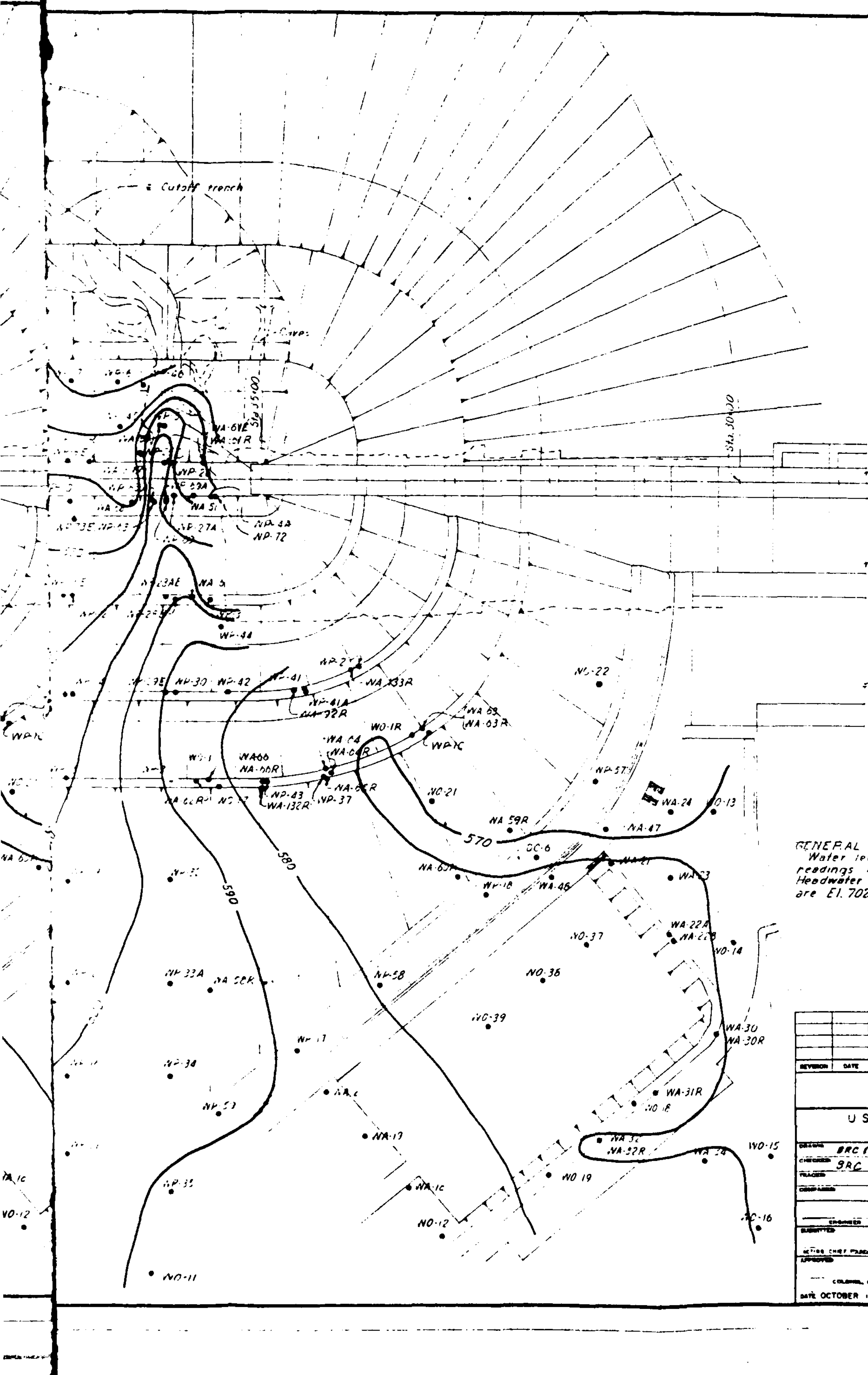
DRAWN DRR & D.
CHECKED BRC

DATE OCTOBER 1973

02-5/63



Cutoff trench
Caves
Caves
Caves
660
650
640
630
620
610
600
590
580
WA-78
NA-15
NA-73R
NP-71
NP-73
NP-7
NP-6
NP-47
NP-52
NP-10
NP-8E
WP-73E
NA-50
NA-49
WP-75
NA-7
WP-4B
NA-3
NA-2
NA-1
NP-49
NP-53
NP-11 E
NA-23AE
WP-44
NA-53
NA-53AE
NA-54
NA-94
WC-3
NP-82
NP-55
WA66
NA-66R
WP-43
WA-132R
NP-37
NP-30
NP-42
NP-41
NP-41A
NP-4A
NP-72
NP-27A
WP-69A
NA-51
NA-6VE
NP-33A
NP-16
NP-34
NP-31
NP-35
WP-22
WO-11
WO-29



GENERAL NOTES
Water level contours are based on piezometer readings made 18 September 1972
Headwater and Tailwater elevations on 18 Sept 1972 are El. 702.3 and 553.5 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

50' 0 50 100'
GRAPHIC SCALE

U S ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

DRAWN BRC & DJ
CHECKED BRC
TRACED
COMPARED

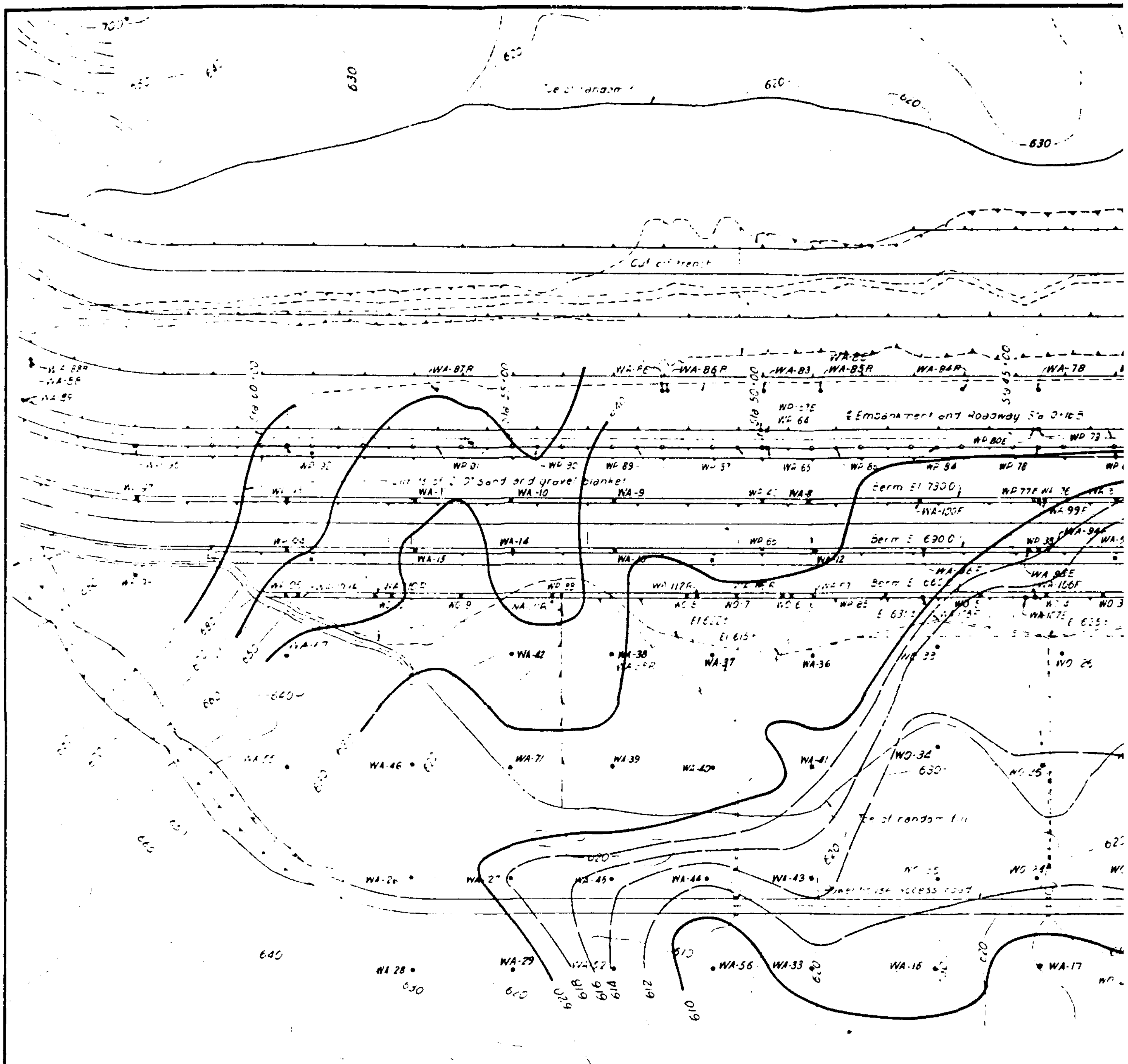
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 18 SEPT 1972

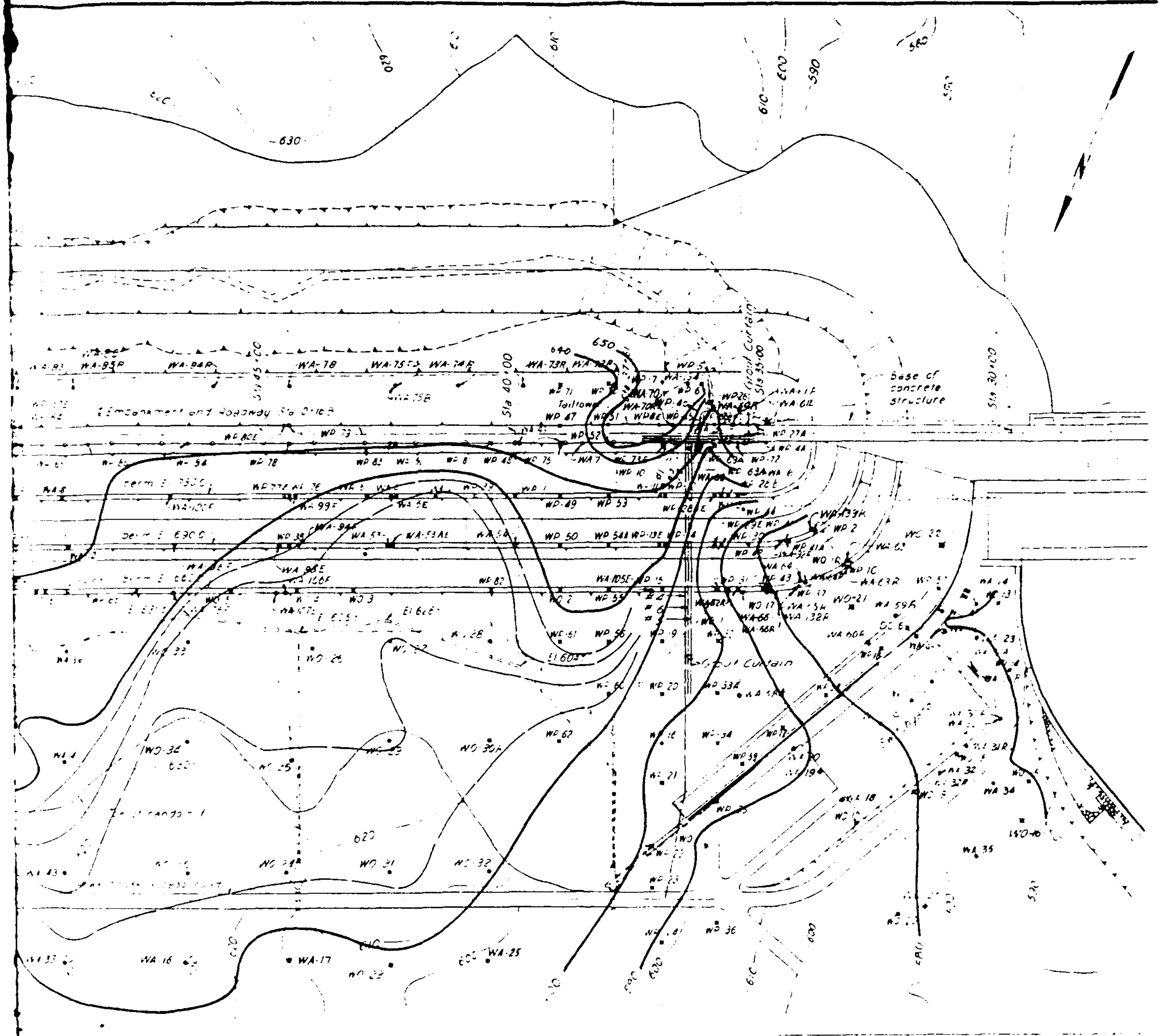
SUBMITTED
ACTING CHIEF FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
SCALE 1"=50
DATE OCTOBER 1973

02-5/70

PLATE B- 6


Cut off trench
€ Embankment and Roadway Sta 0+16.5
Berm El 730.0
Berm El 630.0
WA-87R
WA-86R
WA-83
WA-85R
WA-84R
WA-78
WA-14
WA-42
WA-38
WA-37
WA-36
WA-46
WA-71
WA-39
WA-41
WD-34
WA-28
WA-29
WA-56
WA-33
WA-16
WA-17
WA-44
WA-43
WA-45
630
620
640
612
610
614
616
618

PLAN



PLAN

LEGEND
WA 33E - Embankment Piezometer
WA 33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA 33R - Bedrock Piezometer

GENERAL NOTES
Water level contours are based on piezometer readings made 16 April 1973. Headwater and Tailwater elevations on 16 April are El 1.32 and El 56.0 respectively

REVISION	DATE	DESCRIPTION	BY	CHKD

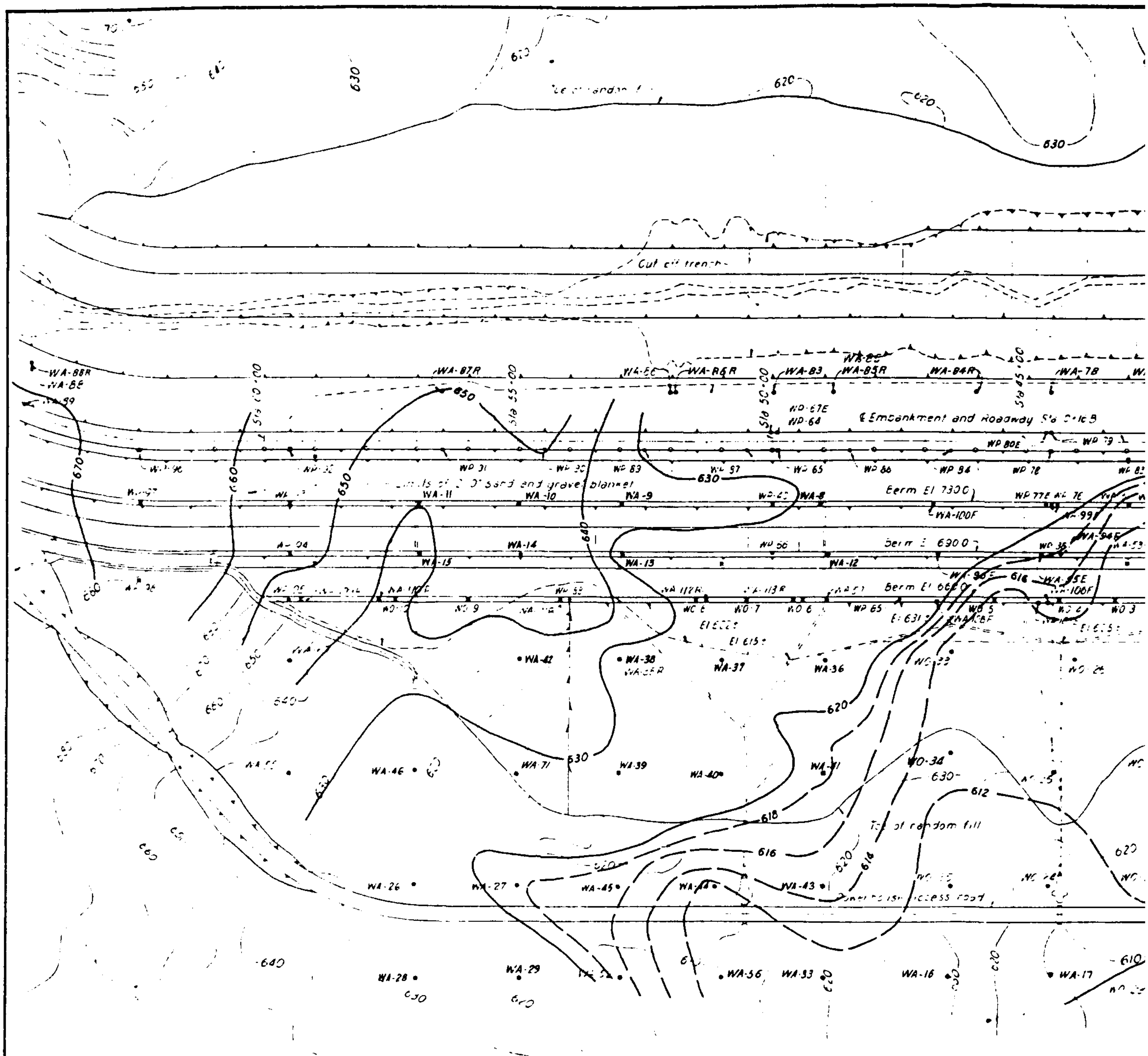
100 0 100 200
GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

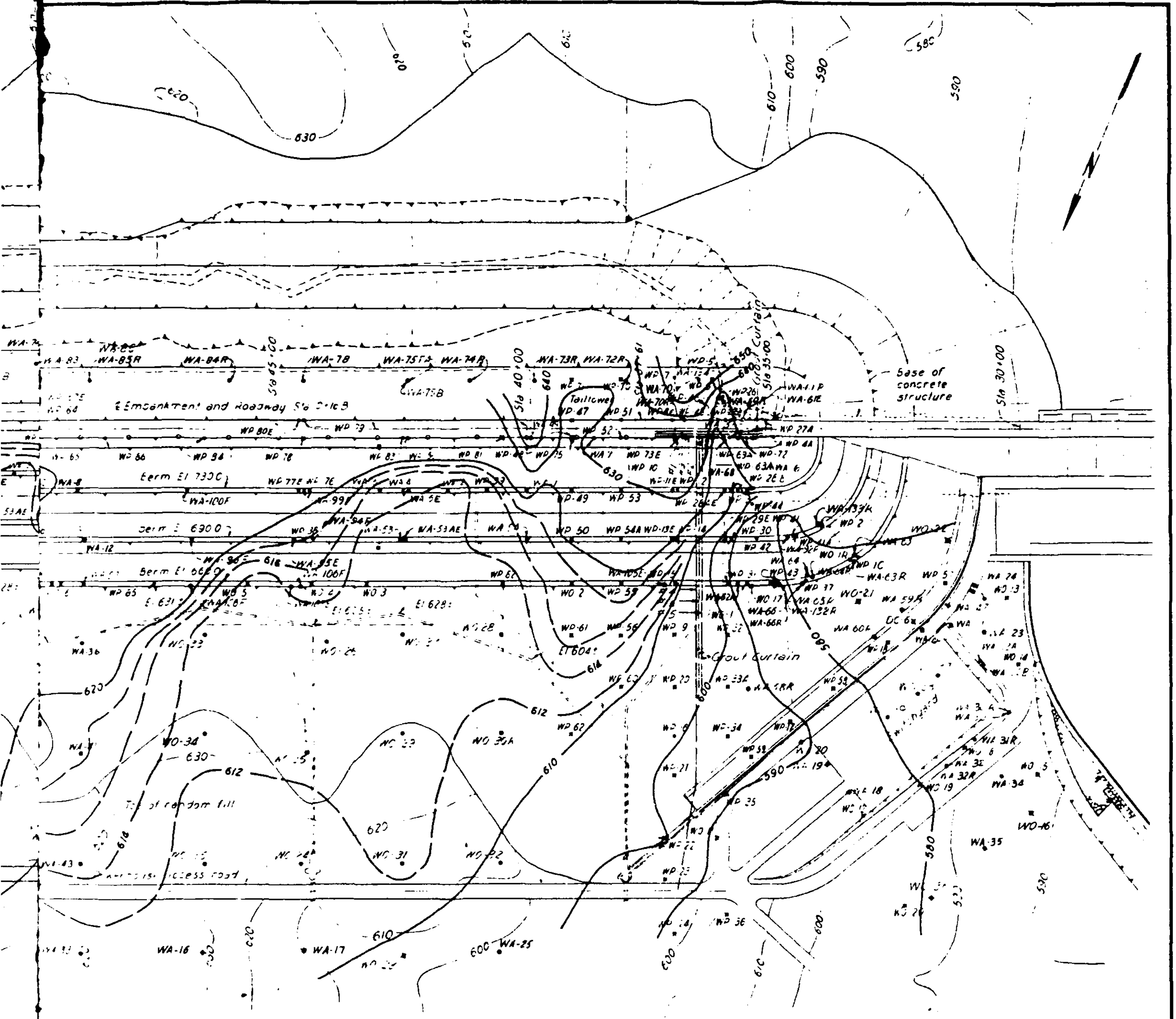
DRAWN BRC & BF
CHECKED BRC
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 16 APR 1973

ENGINEER
SUBMITTED
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
SCALE
DATE OCTOBER 1973
SHEET OF
DRAWING NUMBER
02-5/74


Cut off trench
℄ Embankment and Roadway
Berm El 730.0
Berm El 690.0
Berm El 666.0
Top of random fill
WA-11
WA-10
WA-9
WA-8
WA-14
WA-13
WA-12
WA-42
WA-38
WA-37
WA-36
WA-46
WA-71
WA-39
WA-40
WA-26
WA-27
WA-45
WA-44
WA-43
WA-28
WA-29
WA-56
WA-33
WA-16
WA-17
WA-87R
WA-86R
WA-83
WA-85R
WA-84R
WA-78
WA-100F
WO-34
630
640
650
660
670
680
620
618
616
614
612
610

PLAN



PLAN

LEGEND
WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES
Water level contours are based on piezometer readings made 2 January 1974. Headwater and Tailwater elevations on 2 January 1974 are El 707.7 and El 562.5 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

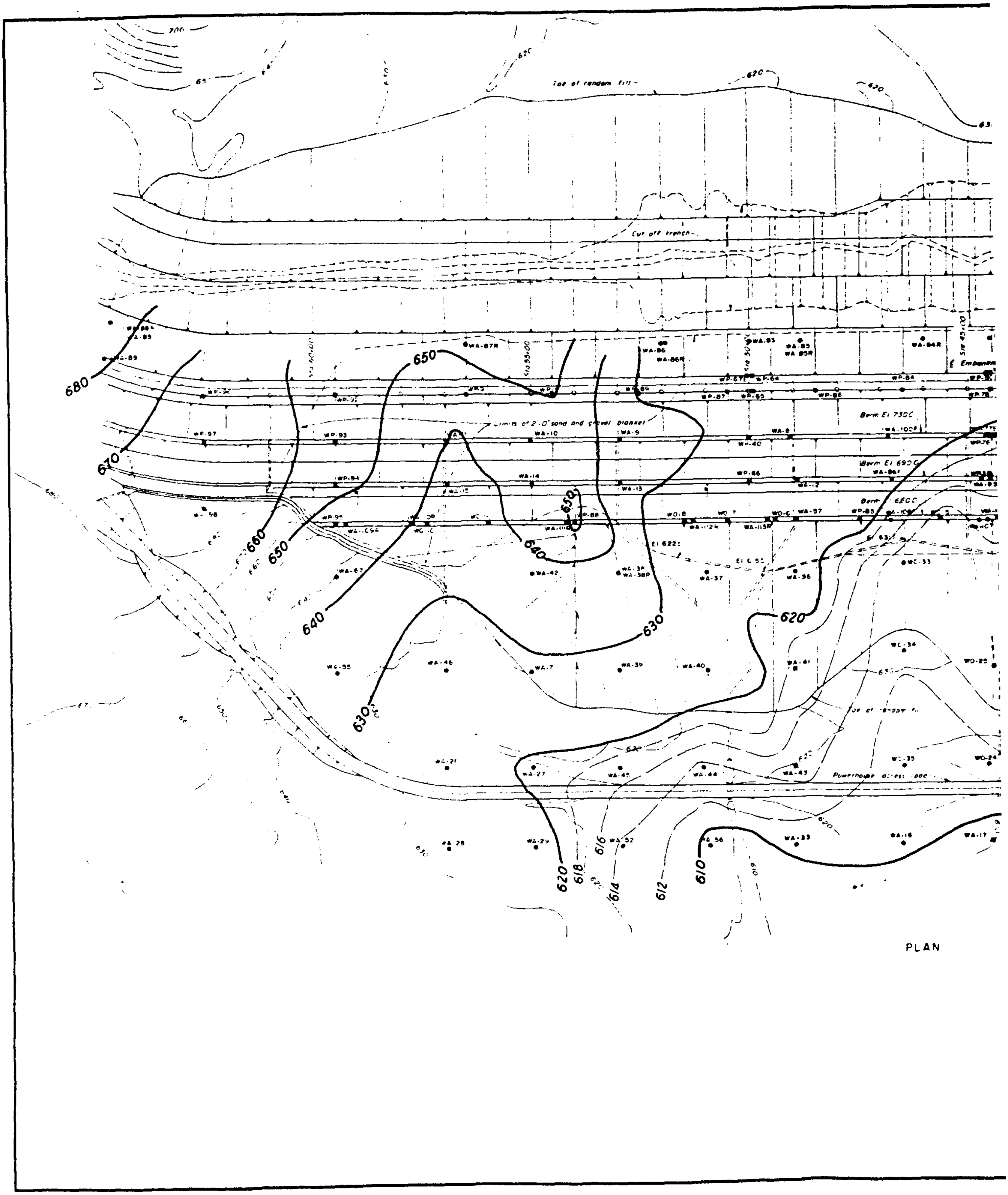
GRAPHIC SCALE

U. S. ARMY ENGINEER DISTRICT, NASHVILLE
NASHVILLE, TENNESSEE

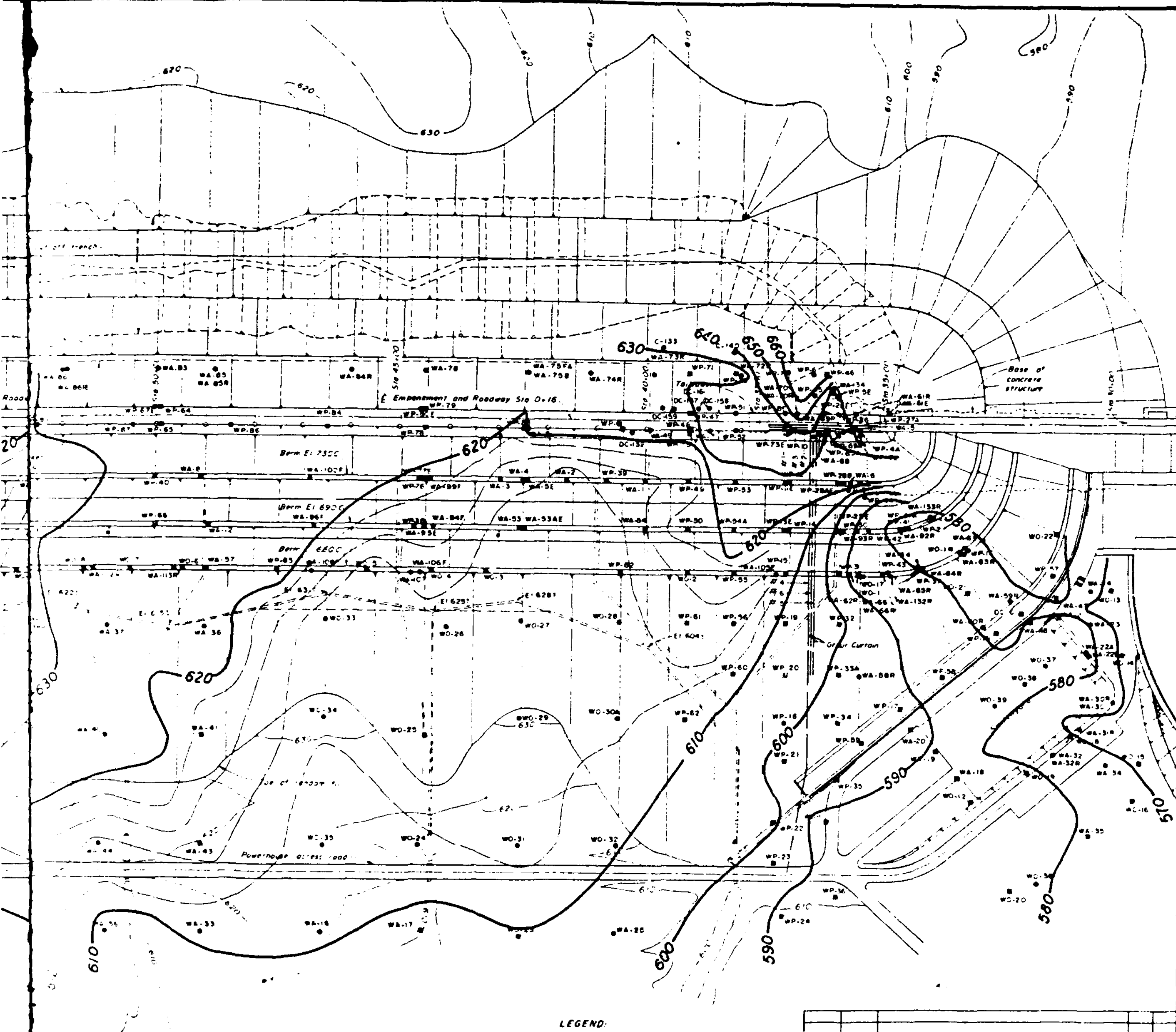
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
READINGS MADE 2 JAN 1974

DRAWN: F M Bailey
CHECKED
TRACED
COMPARED
ENGINEER
SUBMITTED
APPROVAL RECOMMENDED
CHIEF, FOUNDATION AND MATERIALS BRANCH
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C. E. DISTRICT ENGINEER
DATE
SCALE
DRAWING NUMBER
SHEET OF
02-5/81

PLATE B- 8



Toe of random fill
Cut off trench
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Powerhouse
680
670
660
650
640
630
620
618
616
614
612
610
PLAN



PLAN

LEGEND:
WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:
Water level contours are based on piezometer readings made 30 Dec 1974. Headwater and Tailwater elevations on 30 Dec are El 695.9 and El 553.3 respectively.

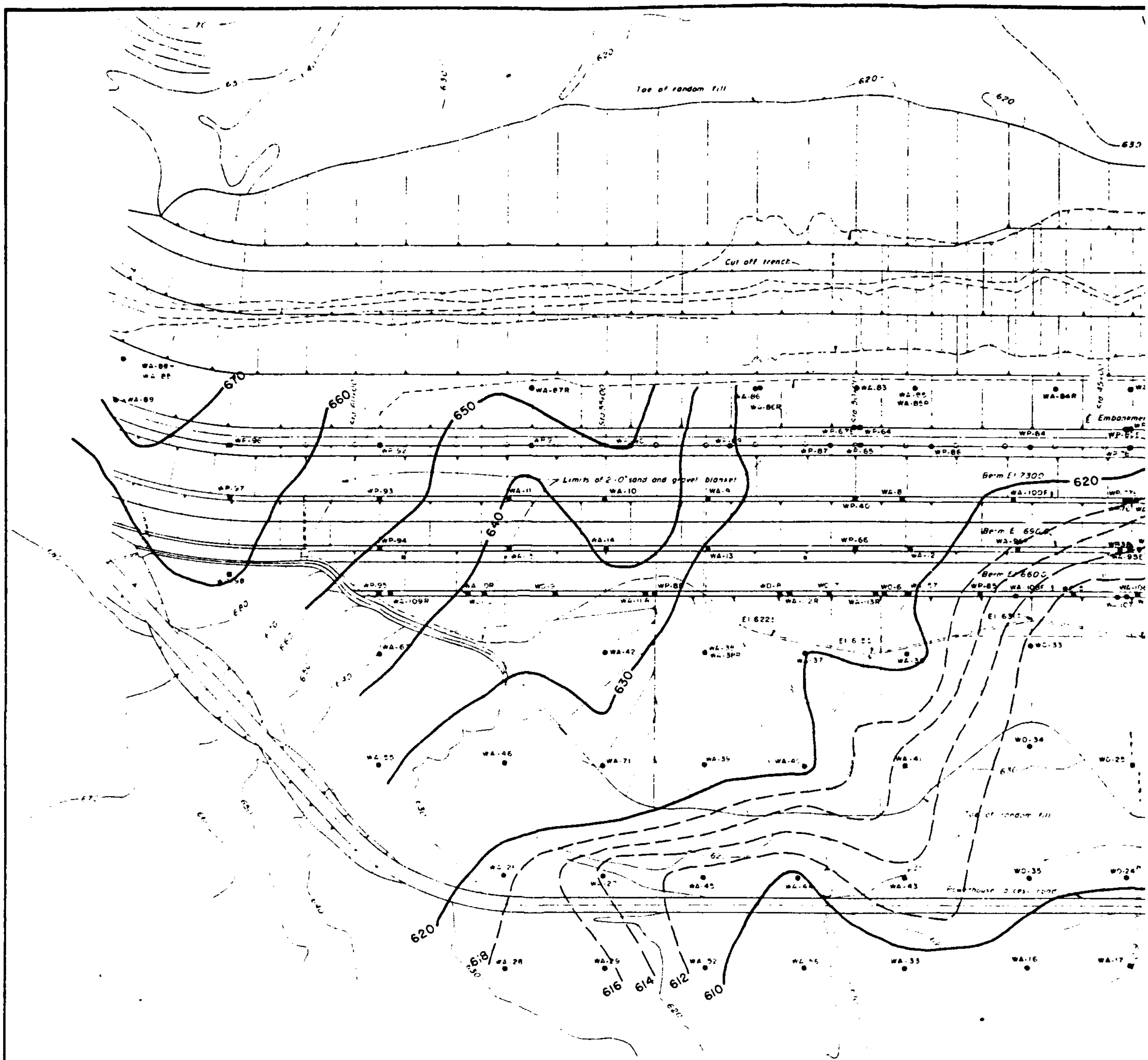
REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN: WHITLEY
CHECKED:
TRACED:
COMPARED:

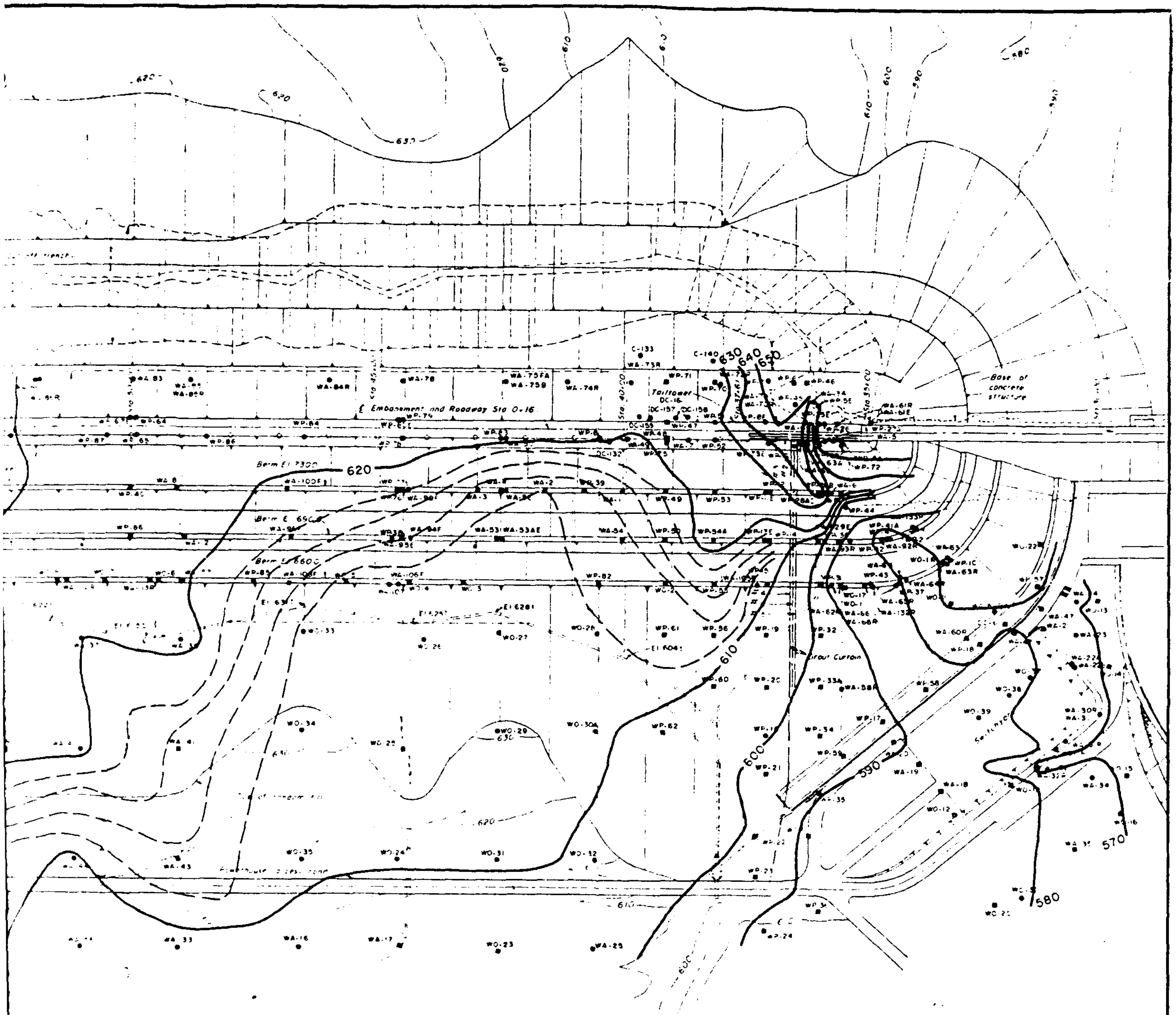
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK

SUBMITTED: CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED: CHIEF, ENGINEERING DIVISION
APPROVED: COLONEL, C. E. DISTRICT ENGINEER
SCALE: 1" = 100' SPEC. NO.
DRAWING NUMBER
DATE SHEET OF 02-5/94



Toe of random fill
Cut off trench
Limits of 2-0" sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Embankment
Toe of random fill
Powerhouse access road
670
660
650
640
630
620
618
616
614
612
610

PLAN



PLAN

LEGEND
WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:
Water level contours are based on piezometer readings made 4 August 1975. Headwater and Tailwater elevations on 7 August are El 683.7 and El 545.0 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

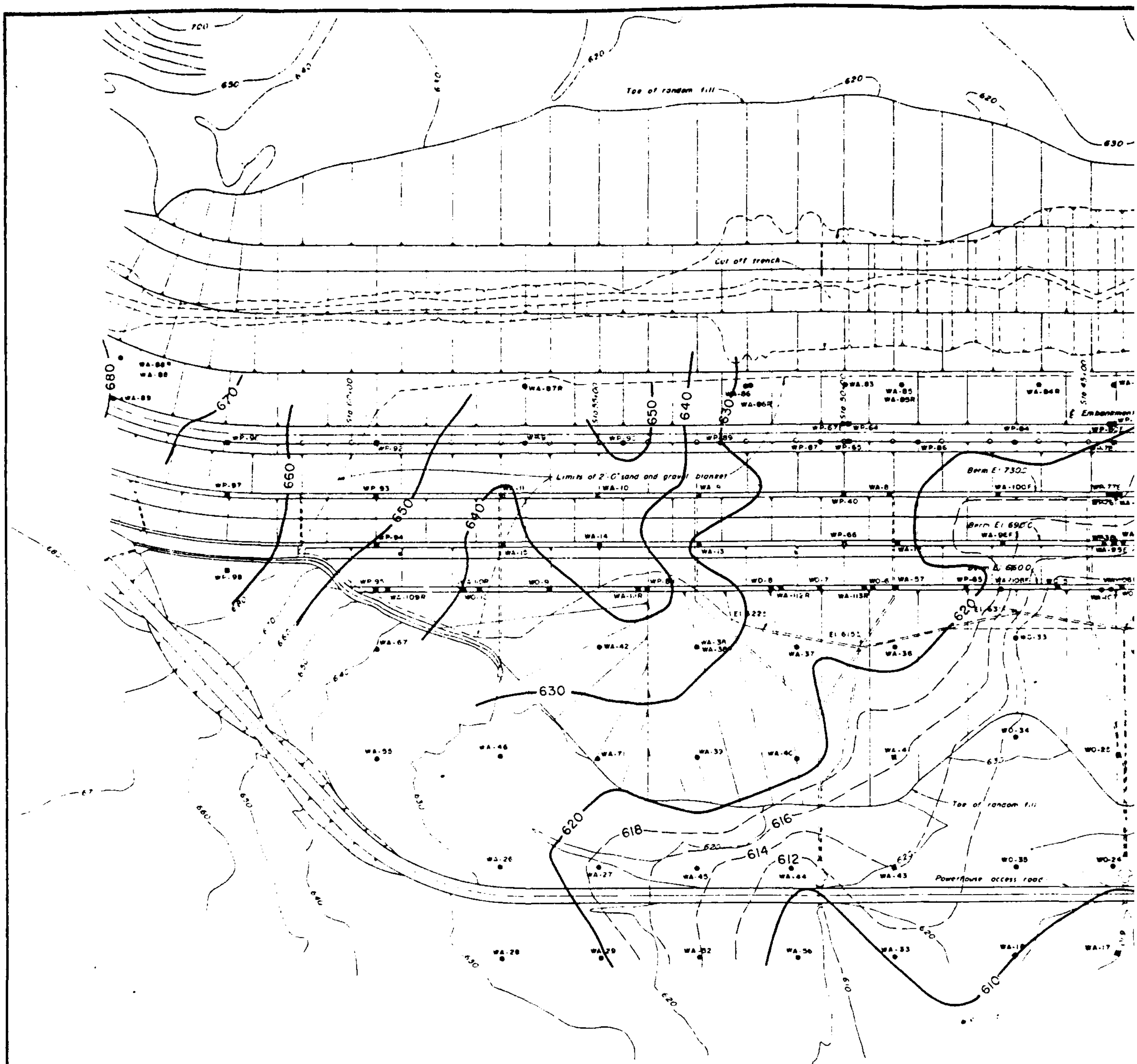
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

DRAWN: LJL
CHECKED
TRACED
COMPARED

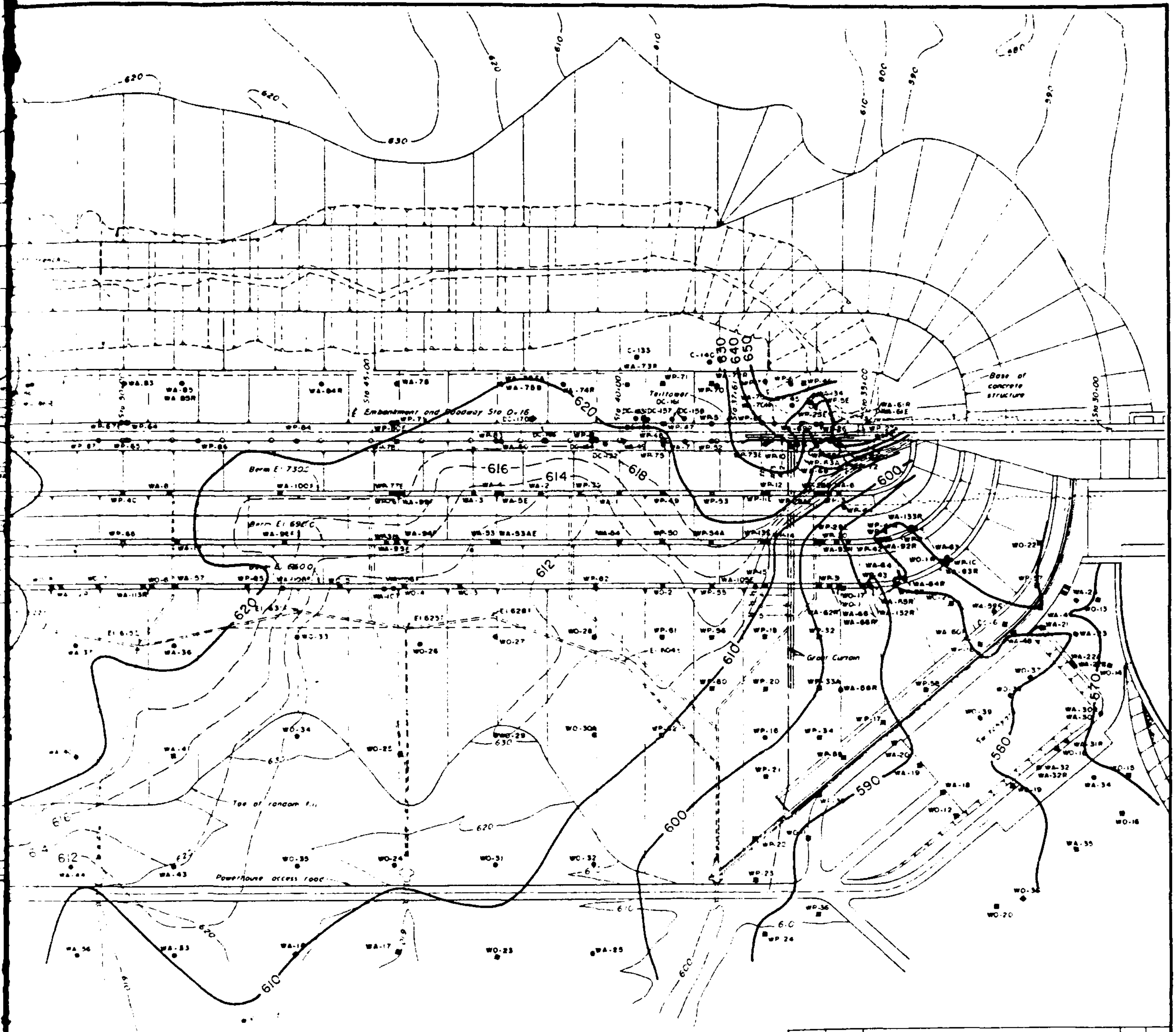
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
4 AUGUST 1975

SUBMITTED
CHIEF, FOUNDATIONS AND MATERIALS BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C E, DISTRICT ENGINEER
DATE
SCALE 1"=100' SPEC NO.
DRAWING NUMBER
SHEET OF
02-5/97



Toe of random fill
Cut off trench
Limits of 2'-0" sand and gravel blanket
Berm El 730.0
Berm El 690.0
Embankment
Toe of random fill
Powerhouse access road
680
670
660
650
640
630
620
618
616
614
612
610

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

Water level contours are based on piezometer readings made 12 July 1976. Headwater and Tailwater elevations on 12 July are El 696.3 and El 559.7 respectively

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

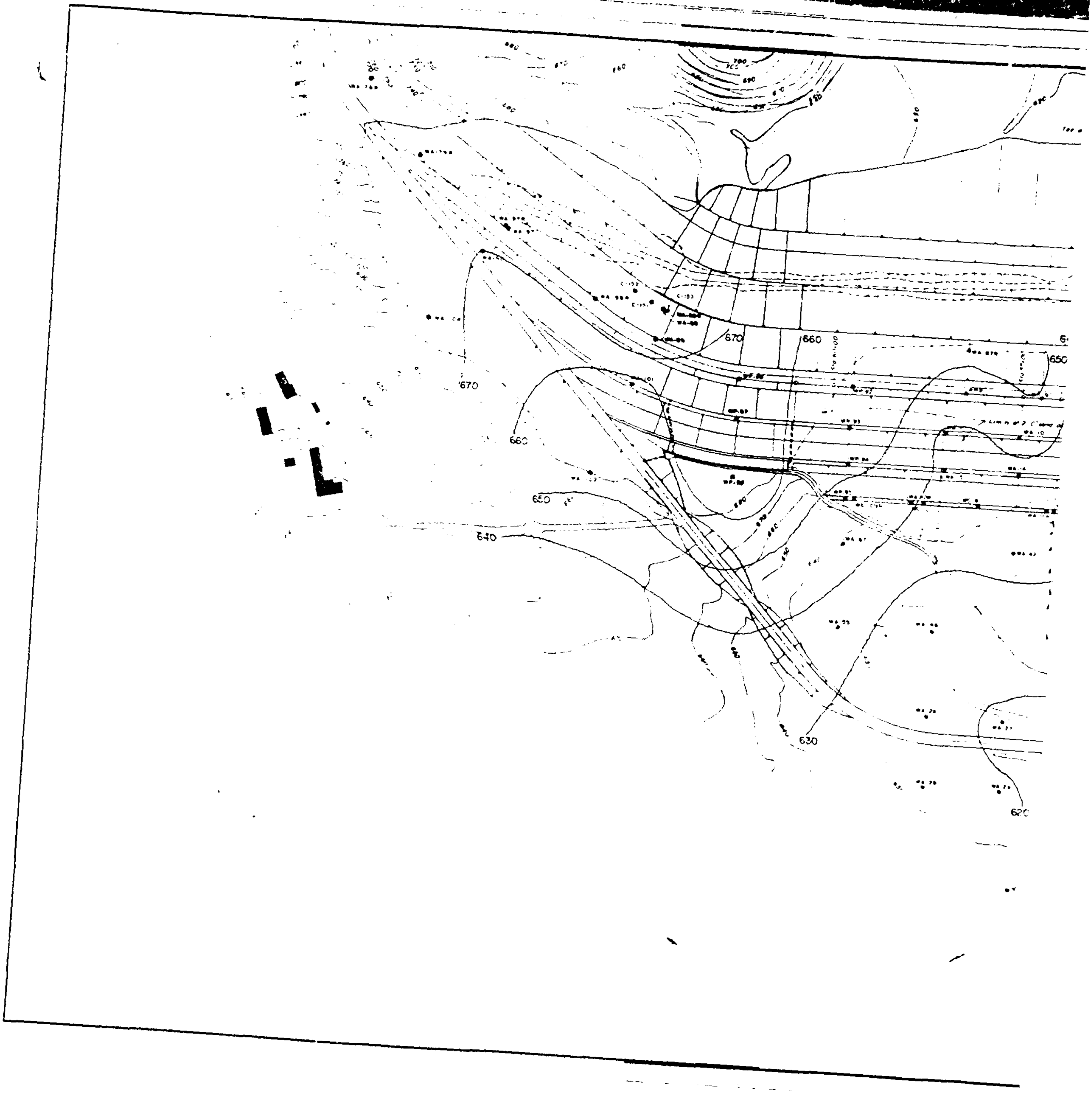
Whitley

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
12 JULY 1976

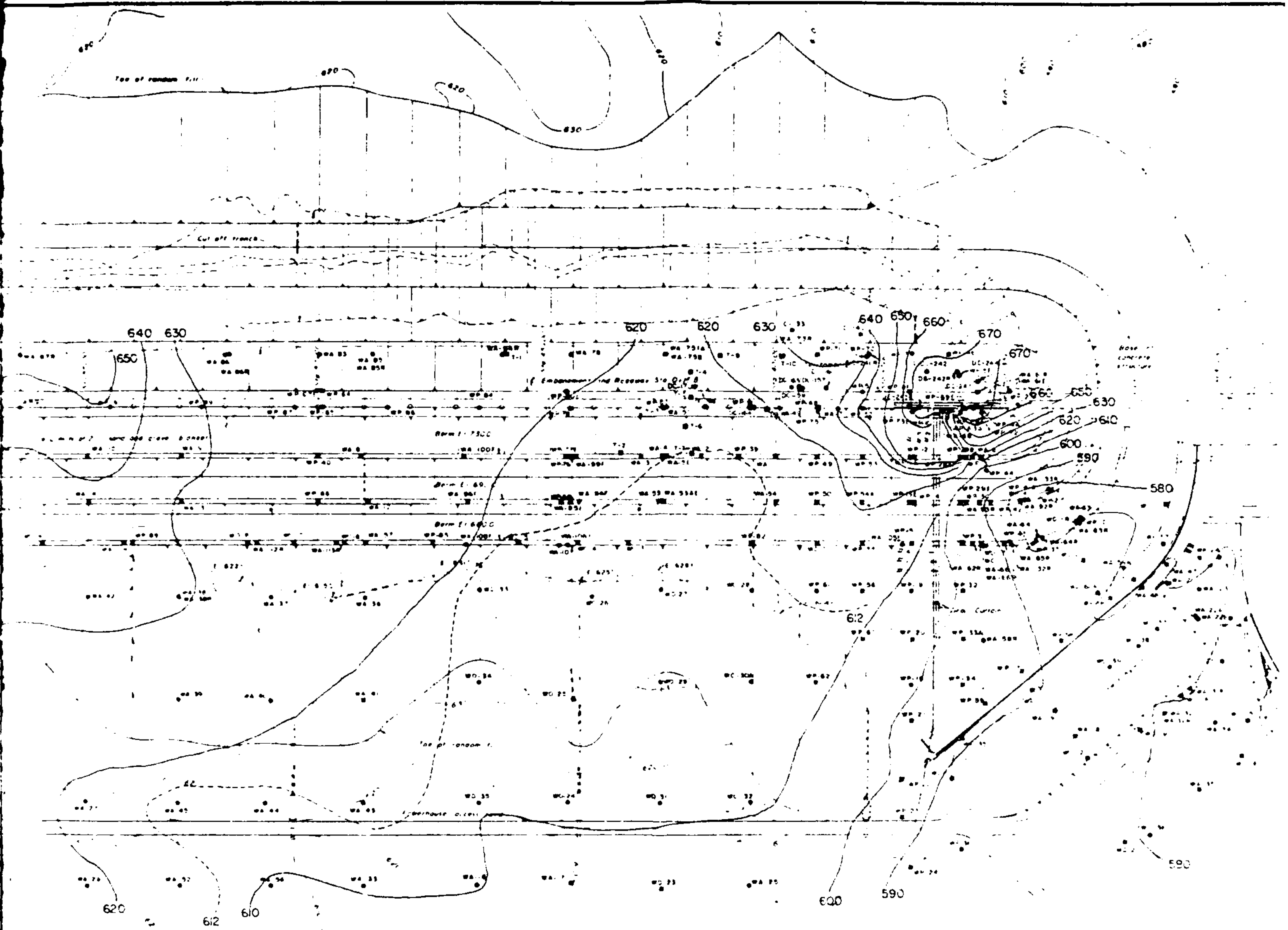
2 AUG 1976

02-5/102

ORIGINAL - Do Not Us



670
660
670
660
650
650
640
630
620



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES

Water level contours are based on piezometer readings made 14 MAR 1977. Headwater and Tailwater elevations on 14 MAR are El 694.7 and El 555.0 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

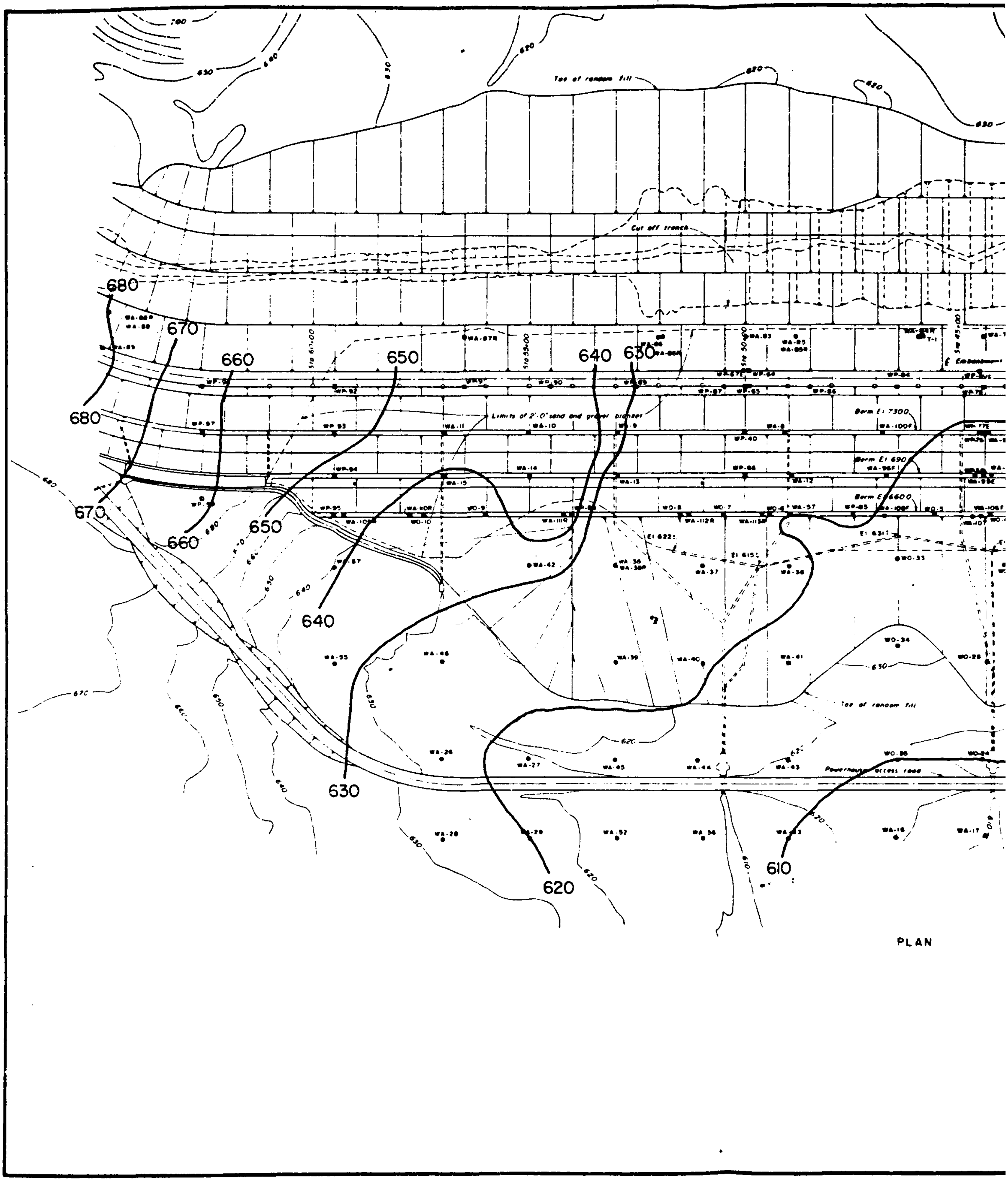
WOLF CREEK RESERVOIR PROJECT

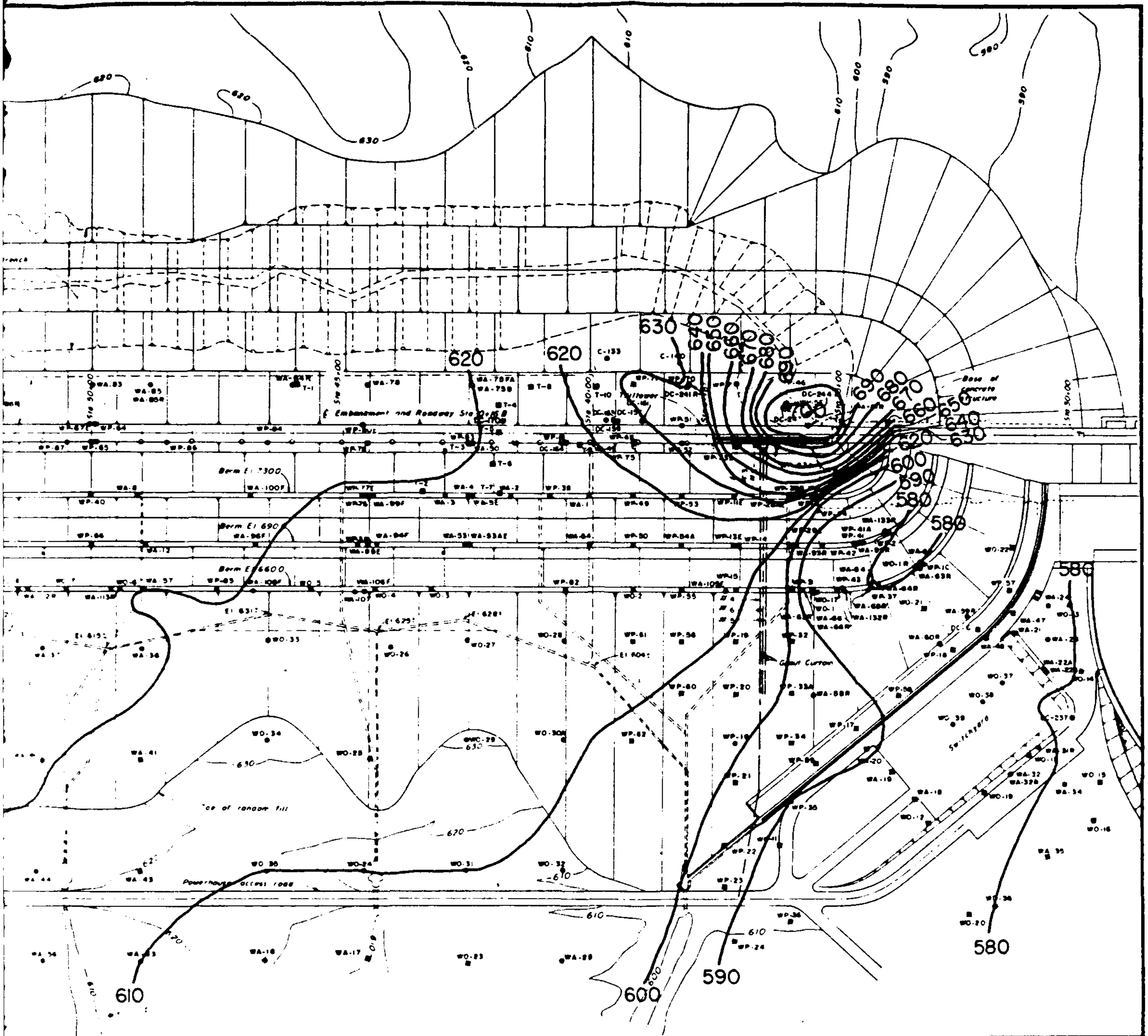
DAM

INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
14 MARCH, 1977

02-5

PLATE B- 12


Toe of random fill
Cut off trench
Limits of 2'-0" sand and gravel blanket
Berm El 7300
Berm El 6900
Berm El 6600
E Embankment
Toe of random fill
Powerhouse access road
680
670
660
650
640
630
620
610
PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

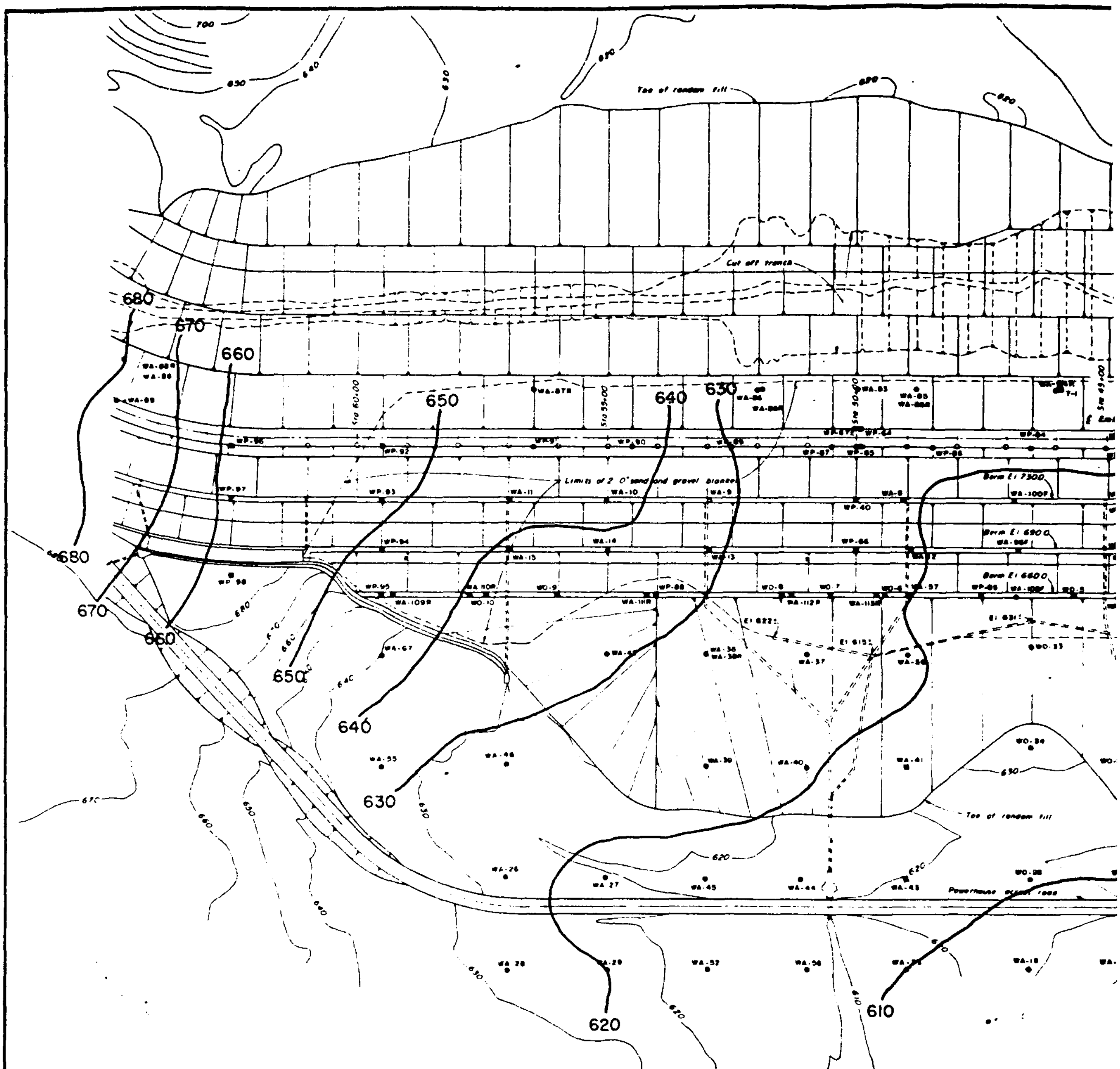
Water level contours are based on piezometer readings made 23 May 1977. Headwater and Tailwater elevations on 23 May are El 691.7 and El 549.2 respectively

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION

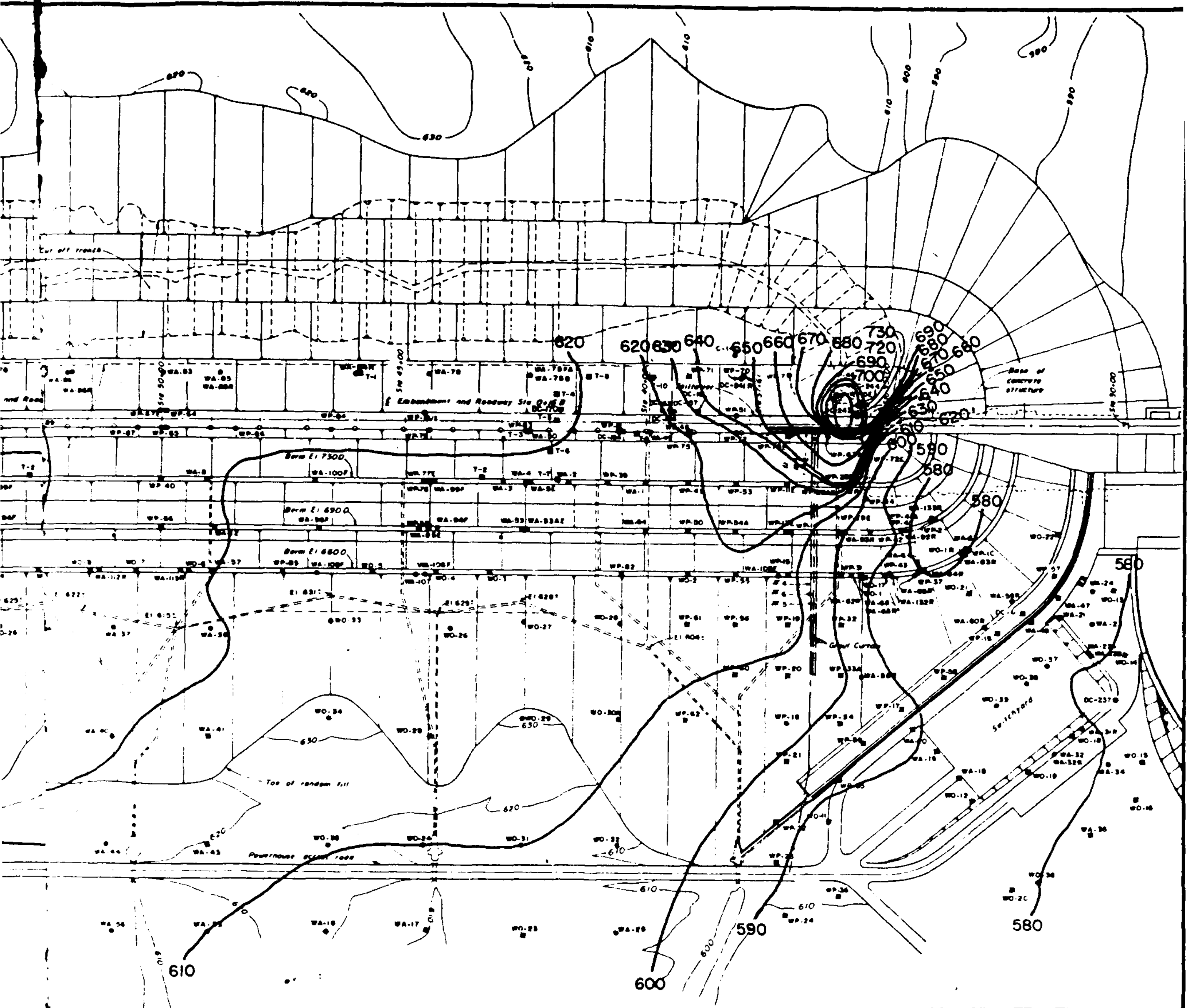
glc

O2-5



Toe of random fill
Cut off trench
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
680
670
660
650
640
630
620
610

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

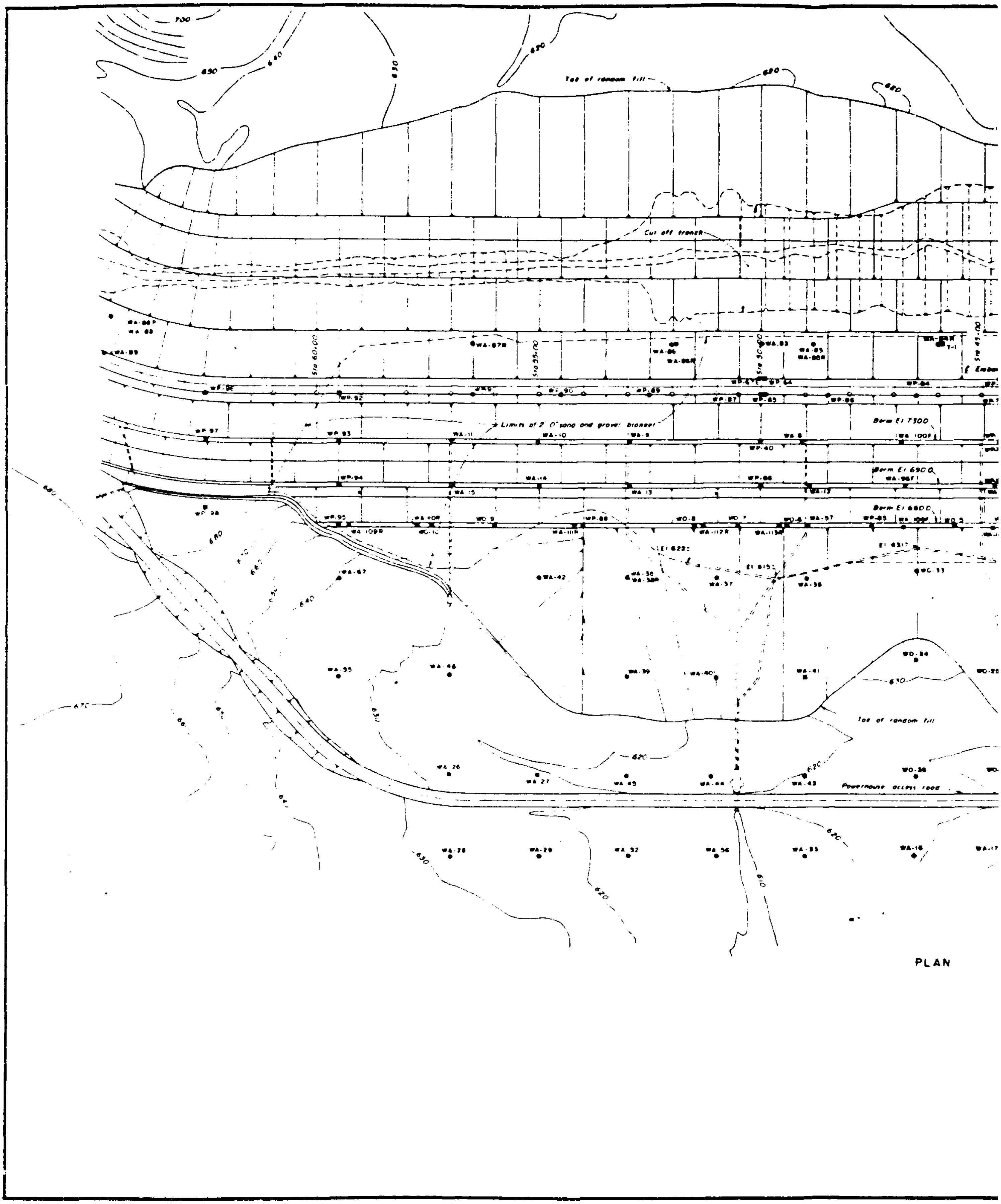
Water level contours are based on piezometer readings made 20 June 1977. Headwater and Tailwater elevations on 20 June are El 688.2 and El 548.9 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION

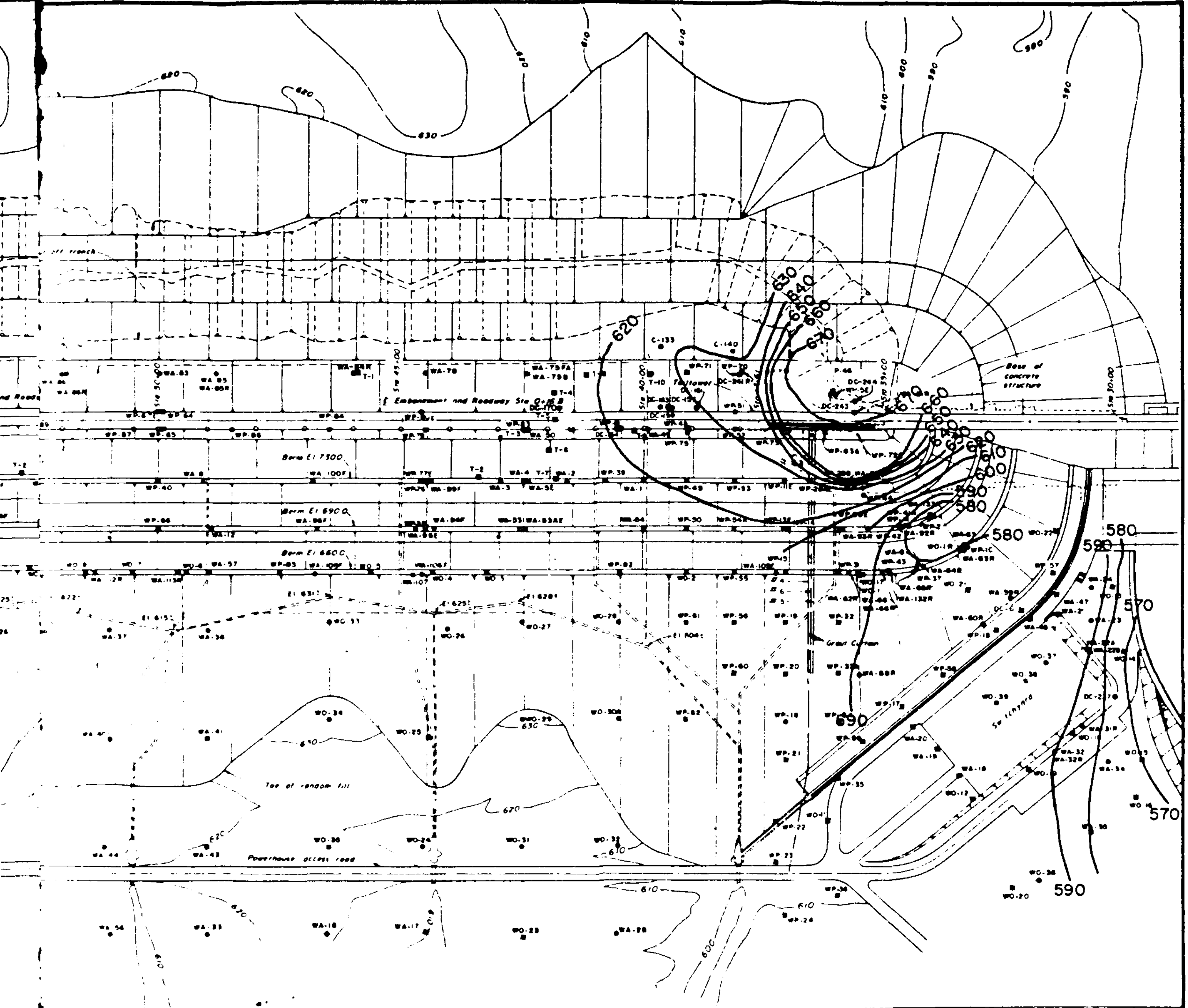
Q2-5

Fin NAL - Do Not



Toe of random fill
Cut off trench
Limits of 2' 0" sand and gravel blanket
Berm El 7300
Berm El 6900
Berm El 6600
Toe of random fill
Powerhouse access road
Sta 60+00
Sta 55+00
Sta 50+00
Sta 45+00

PLAN



PLAN

LEGEND:
WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:
Water level contours are based on piezometer readings made 5 July 1977. Headwater and Tailwater elevations on 5 July are El. 691.0 and El 559.2 respectively.

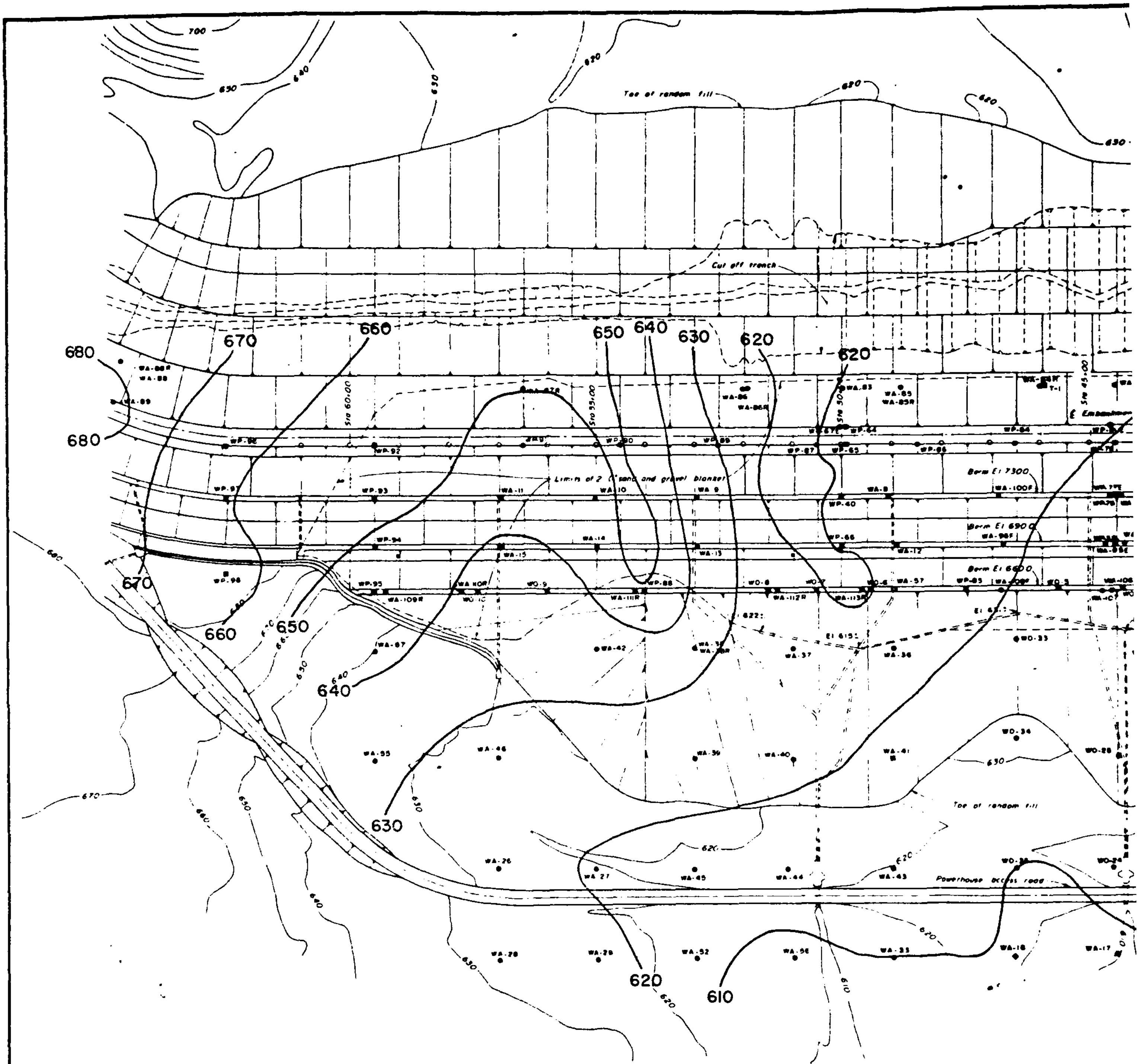
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
5 JULY 1977

02-5

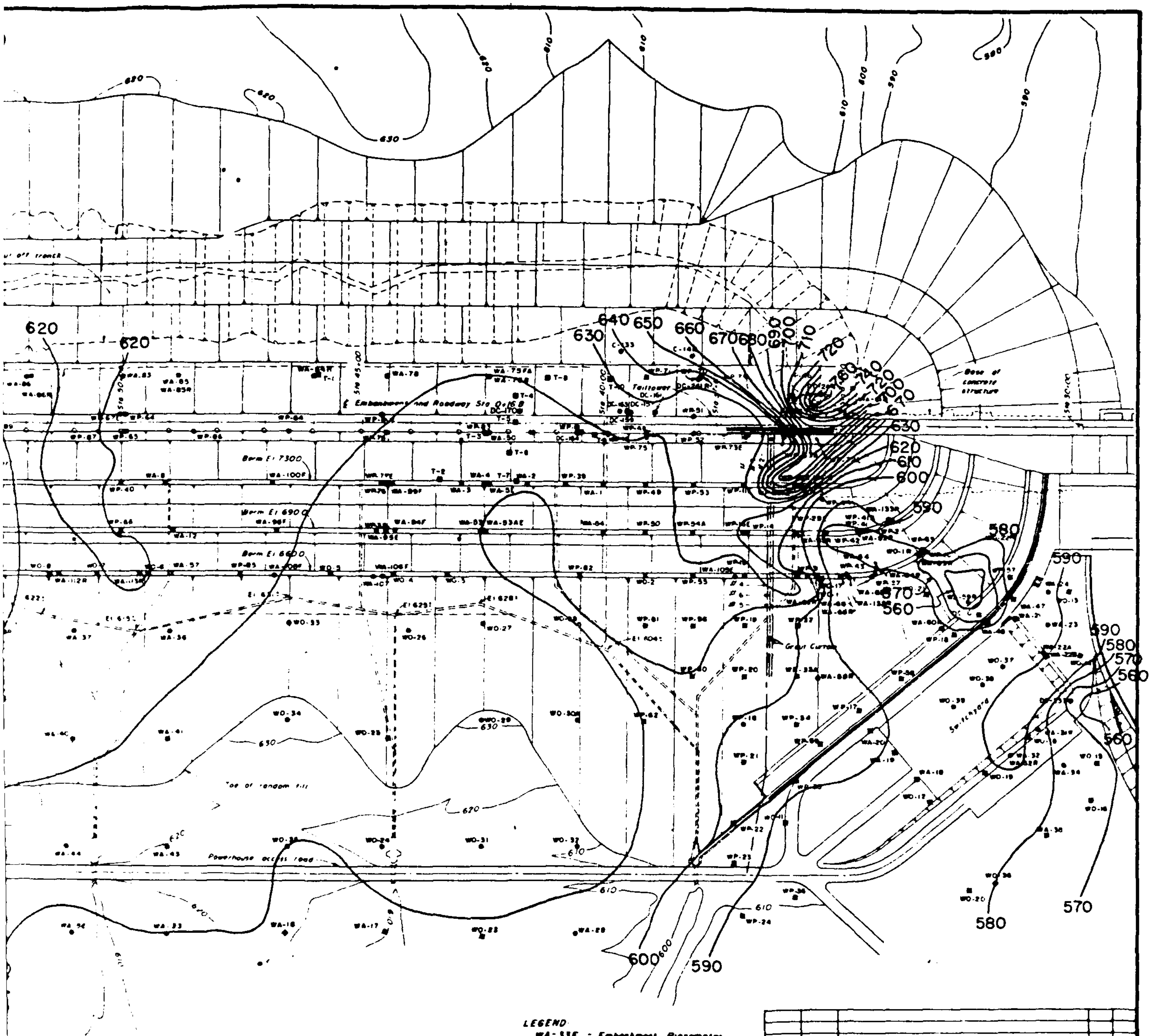
NAL - Do Not U

PLATE B- 15



680
670
660
650
640
630
620
610
Toe of random fill
Cut off trench
Limits of 2' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Powerhouse access road
Embankment

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

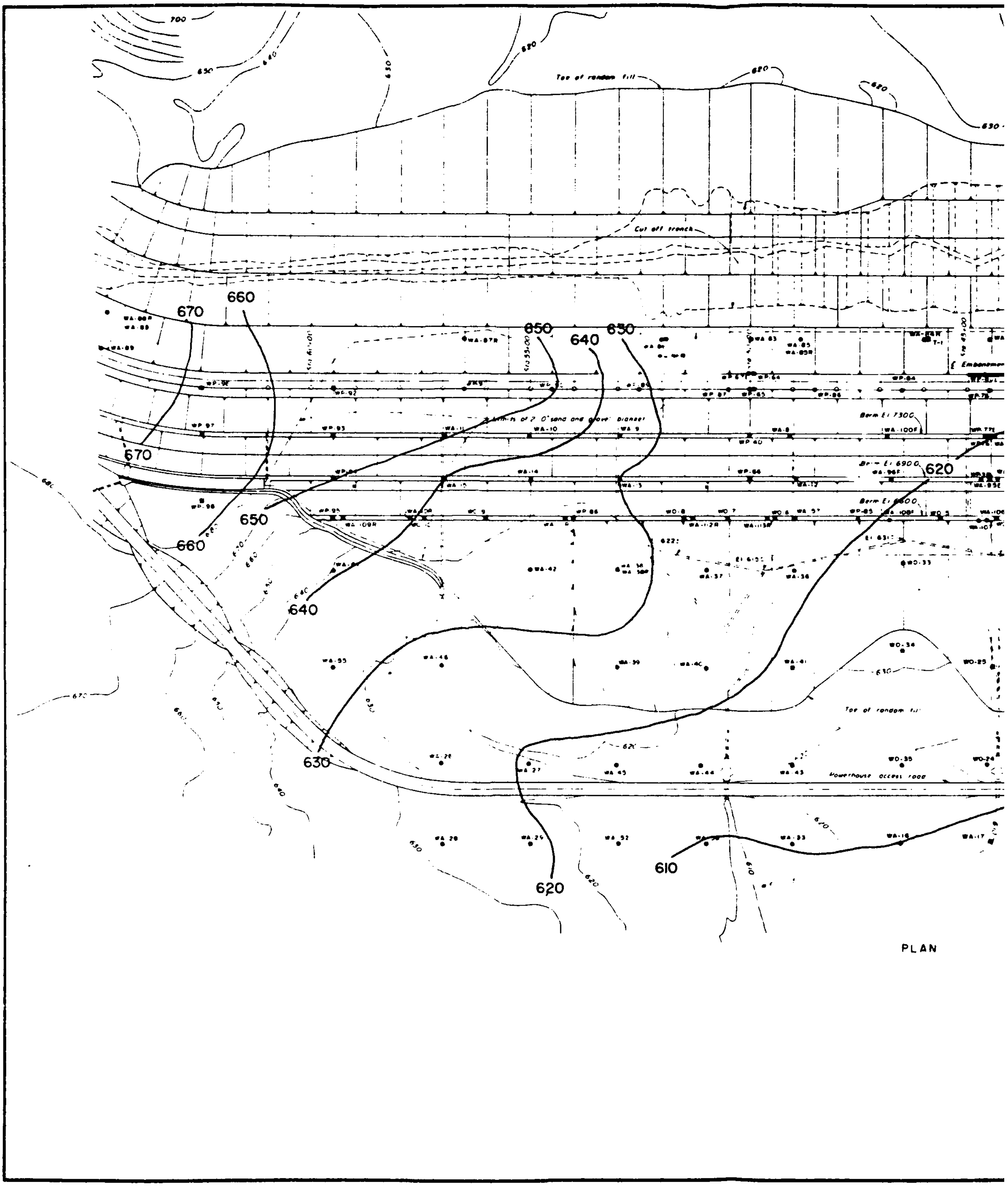
GENERAL NOTES:

Water level contours are based on piezometer readings made July 11 1977. Headwater and Tailwater elevations on July 11 are El. 689.2 and El 543.3 respectively

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

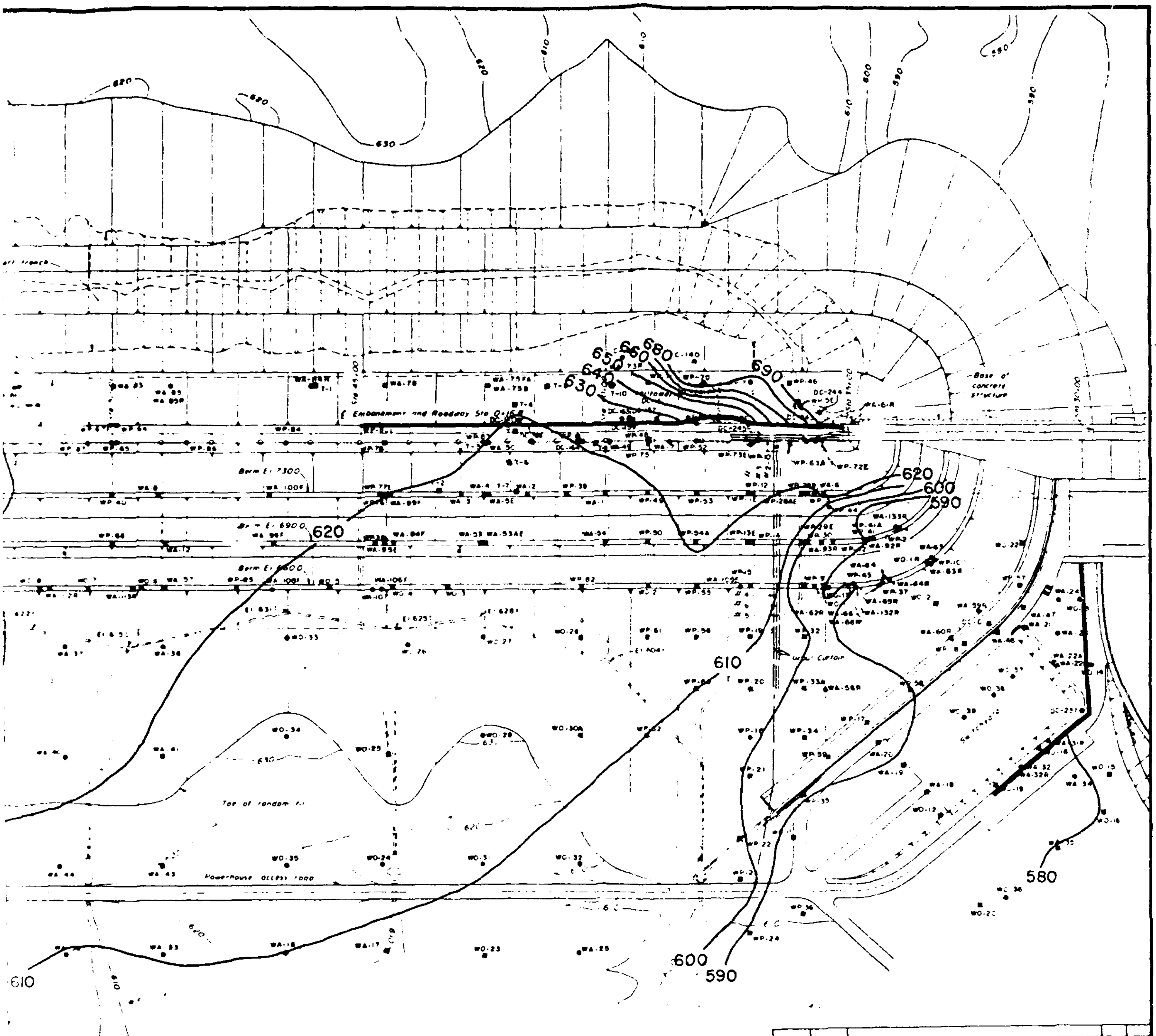
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION

PLATE B- 16



Toe of random fill
Cut off trench
670
660
650
640
630
620
610
Berm El 7300
Berm El 6900
Berm El 6800
Toe of random fill
Powerhouse access road

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

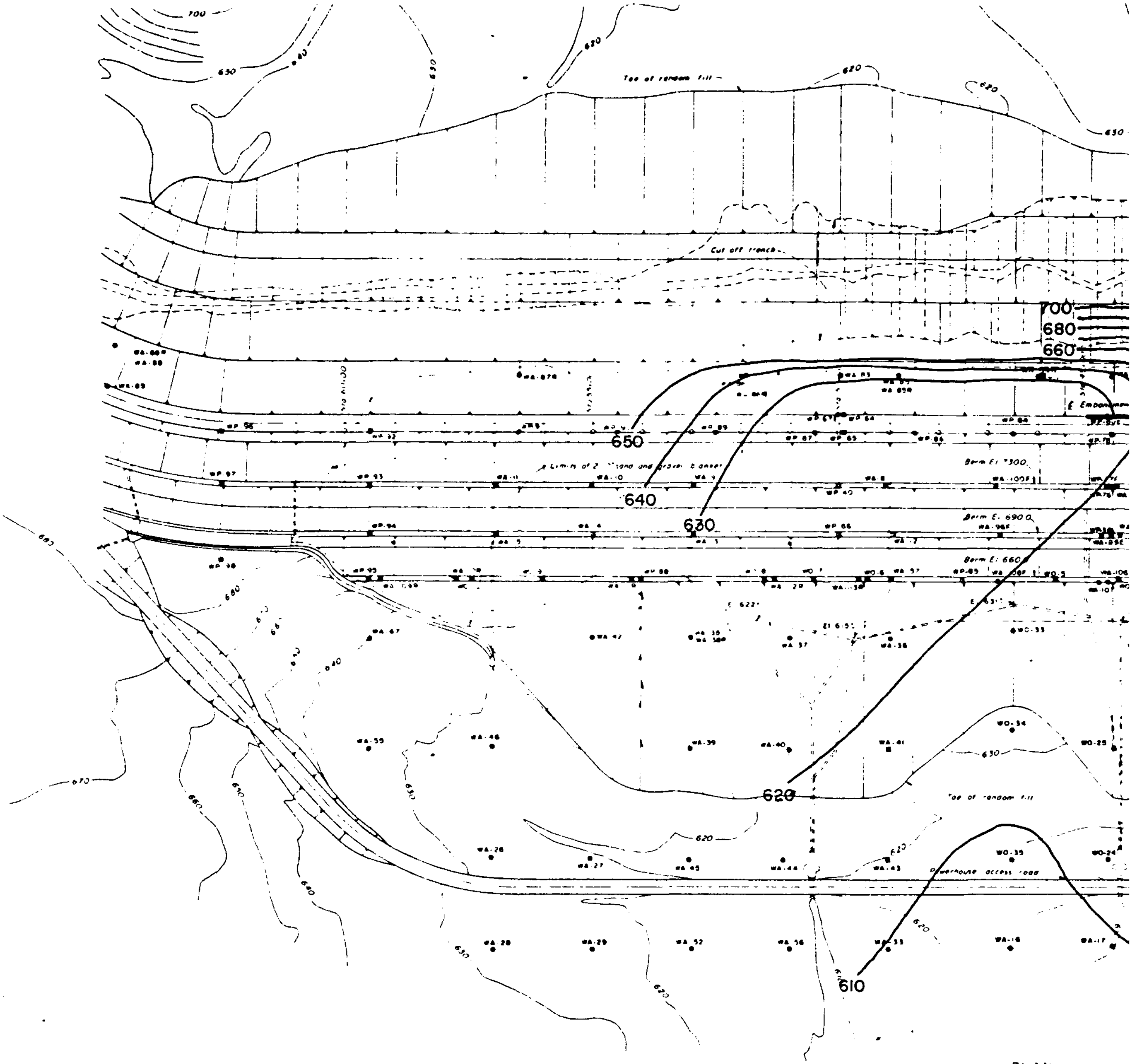
Water level contours are based on piezometer readings made 12 Dec. 1977. Headwater and Tailwater elevations on 12 Dec are El 709.1 and El 558.2 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

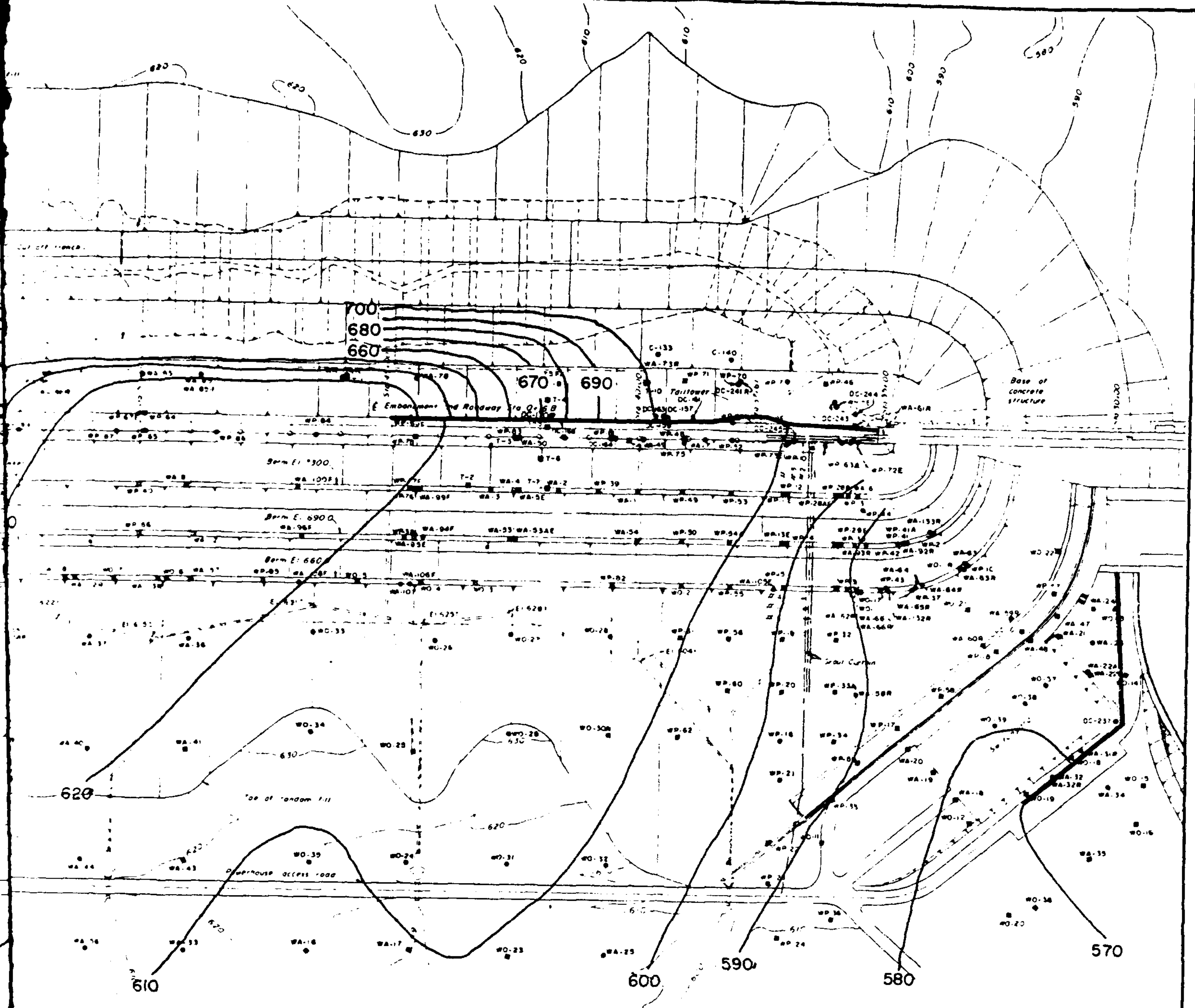
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
12 DECEMBER 1977

Q2-5

PLATE B- 17


700
680
660
650
640
630
620
610
Toe of random fill
Cut off trench
Berm El. 690.0
Berm El. 660.0
Powerhouse access road

PLAN



LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

Water level contours are based on piezometer readings made 1 Feb. 1978. Headwater and Tailwater elevations on 1 Feb. are El 700.0 and El 558.0 respectively.

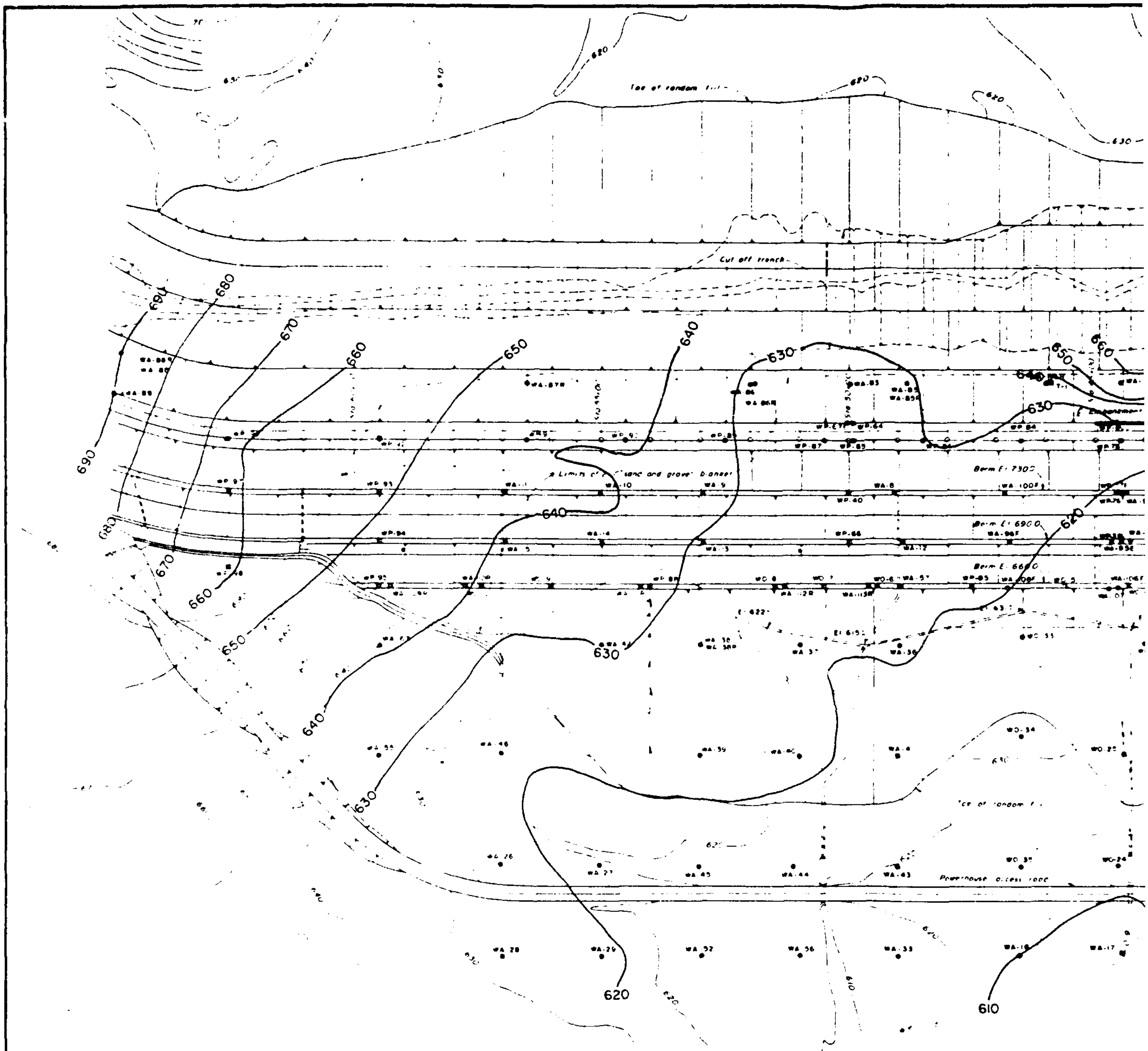
THEORETICAL TOP OF ROCK PIEZOMETRIC CONTOURS AS OF 1 FEB 1978

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
1 FEBUARY 1978

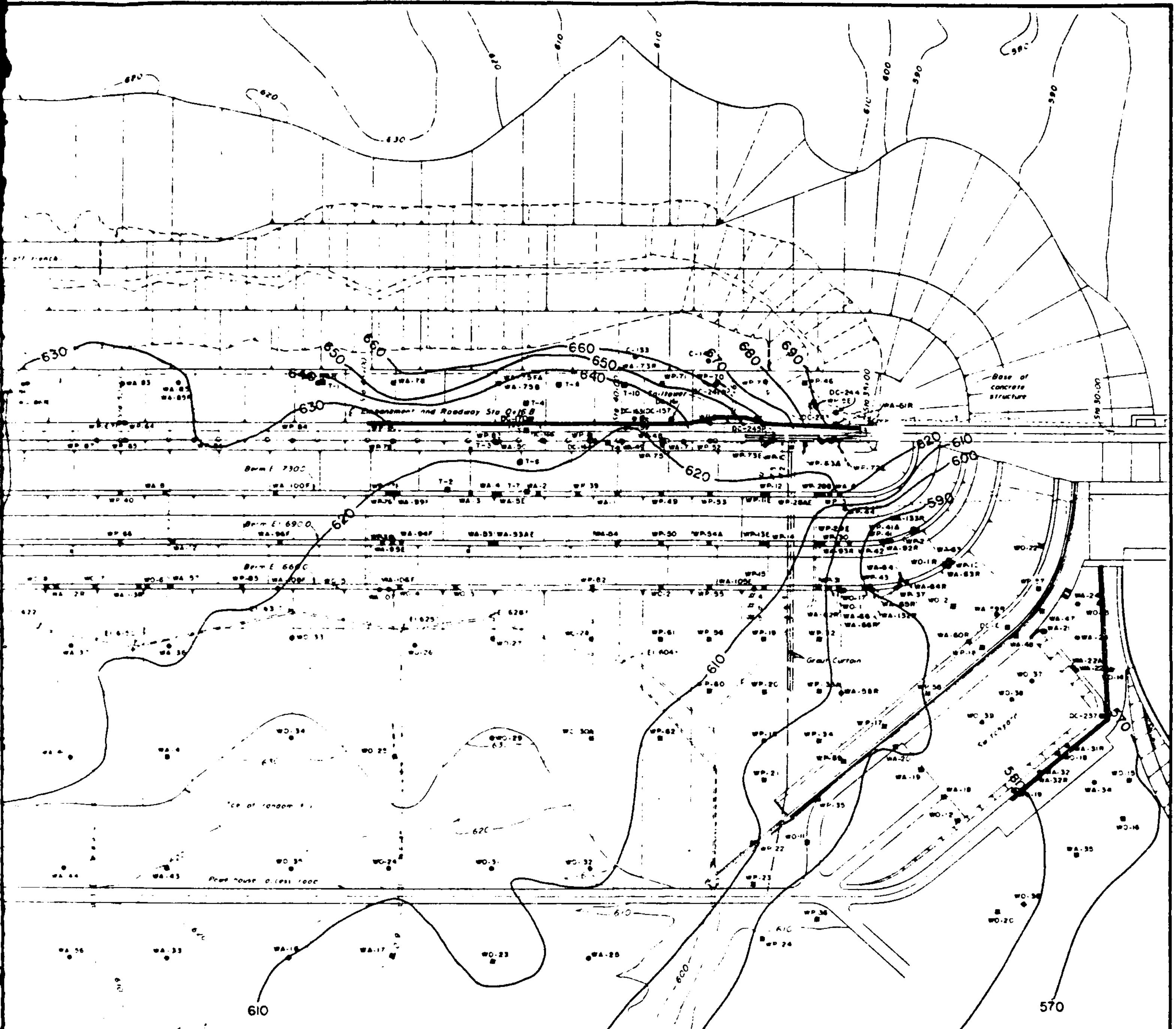
02-5

PLATE B- 18



Toe of random fill
Cut off trench
Limits of sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Toe of random fill
Powerhouse access road
690
680
670
660
650
640
630
620
610

PLAN



LEGEND
WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

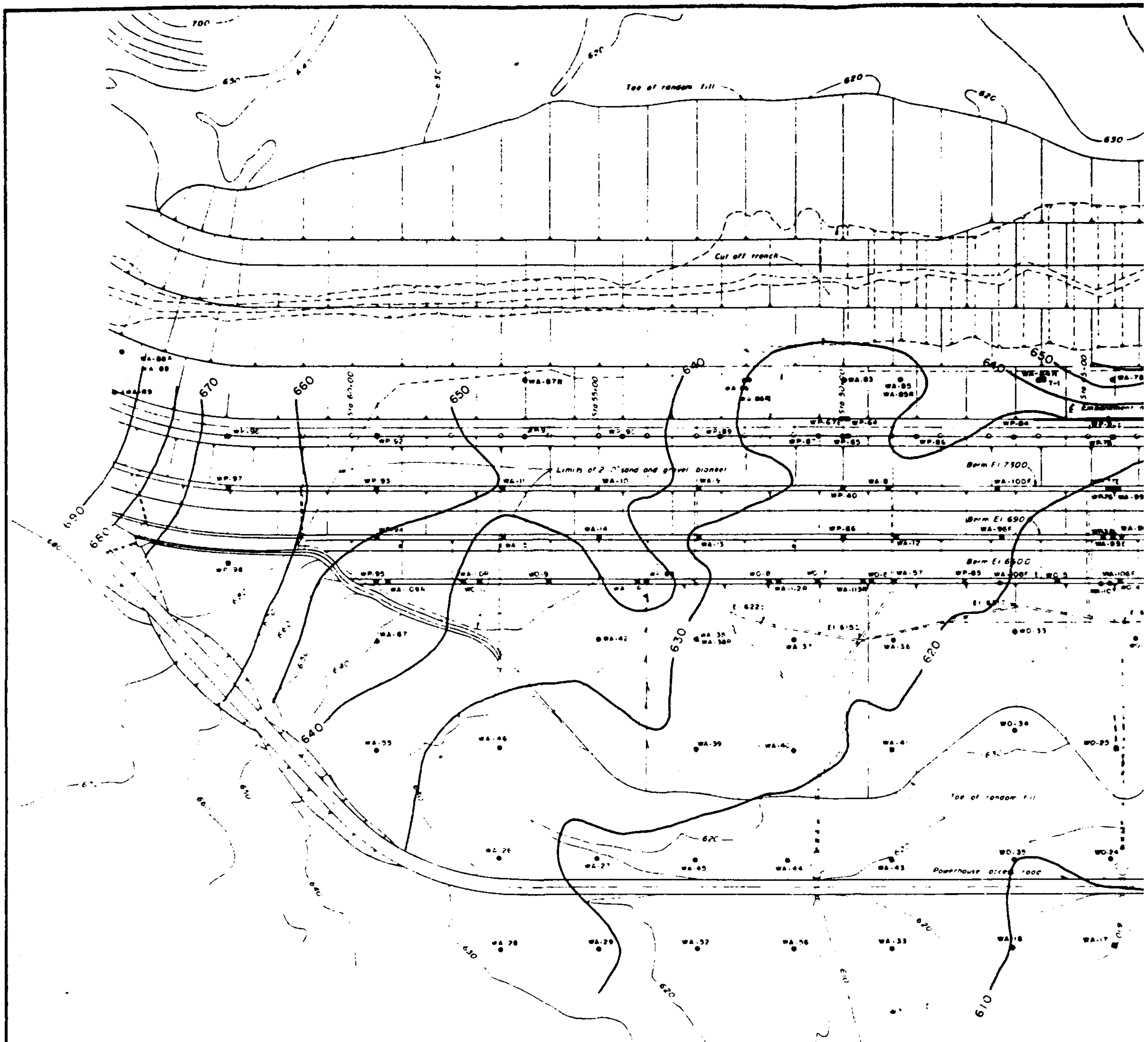
GENERAL NOTES:
Water level contours are based on piezometer readings made 10 April 1978. Headwater and Tailwater elevations on 10 April are El 714.1 and El 545.7 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION

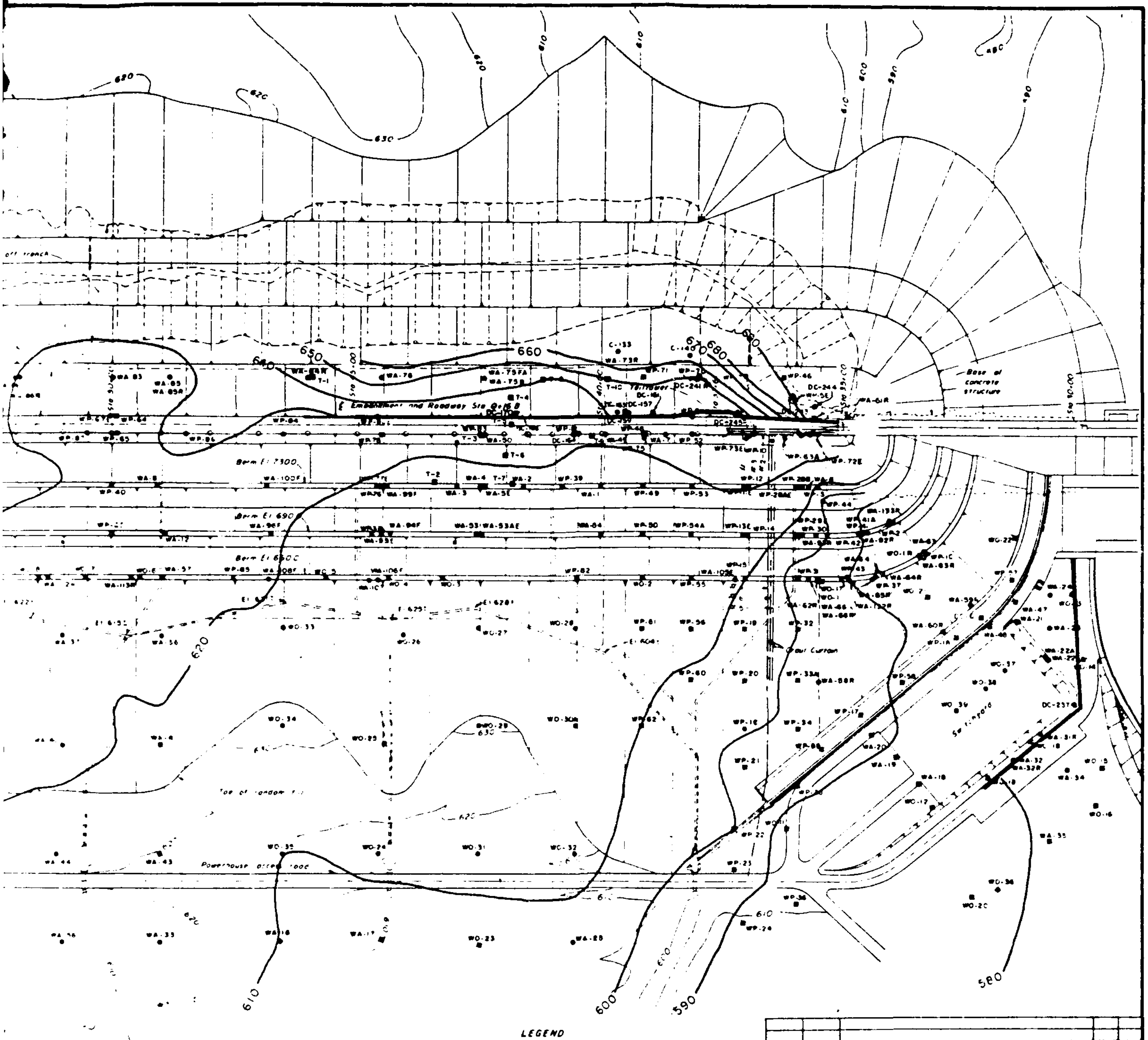
02-5

PLATE B- 19



Toe of random fill
Cut off trench
Limits of 2.0' sand and gravel blanket
Berm El 7300
Berm El 690
Berm El 6500
Powerhouse access road
700
690
680
670
660
650
640
630
620
610

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

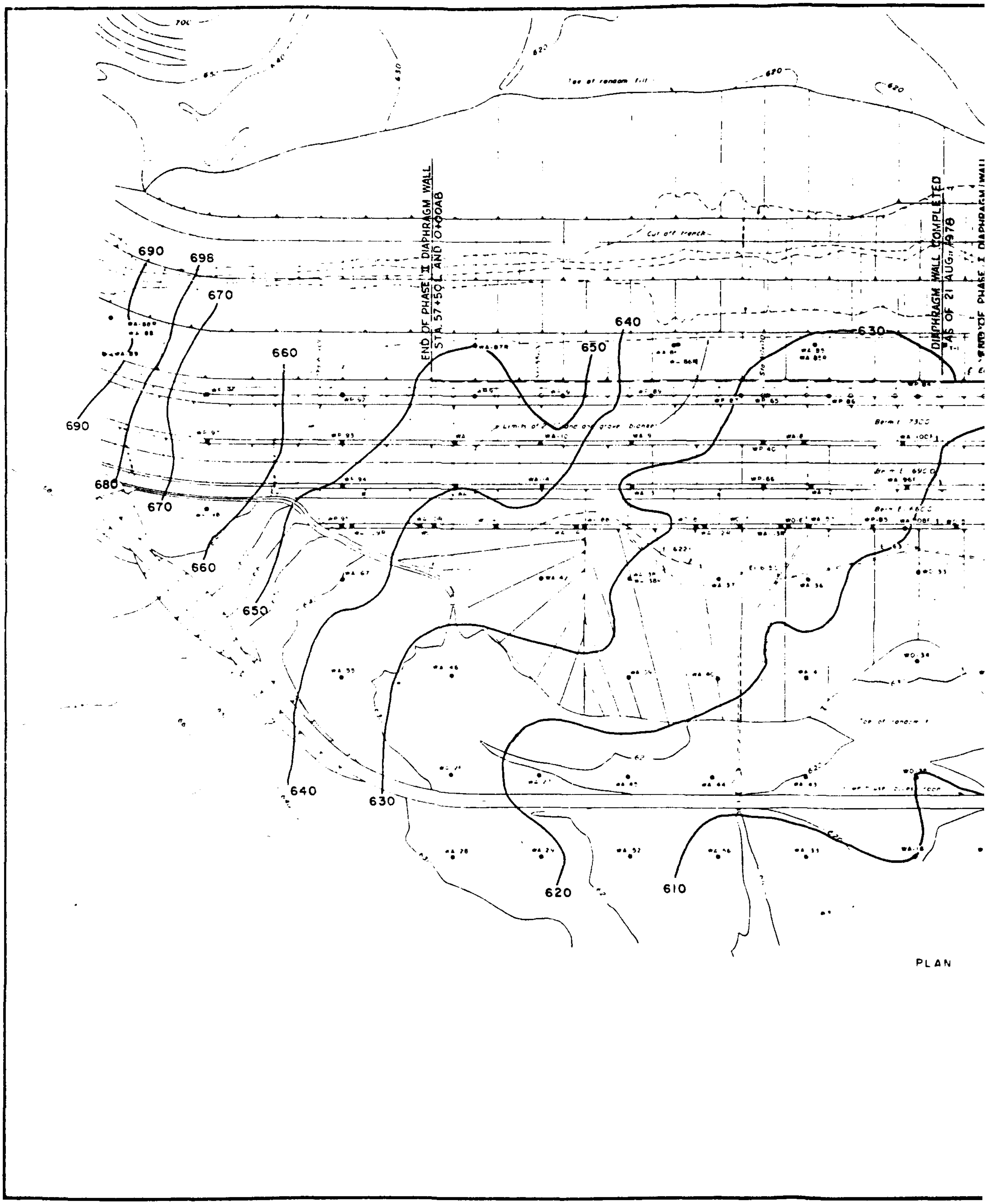
GENERAL NOTES:

Water level contours are based on piezometer readings made 30 May 1978. Headwater and Tailwater elevations on 30 May are El 724.3 and El 558.6 respectively.

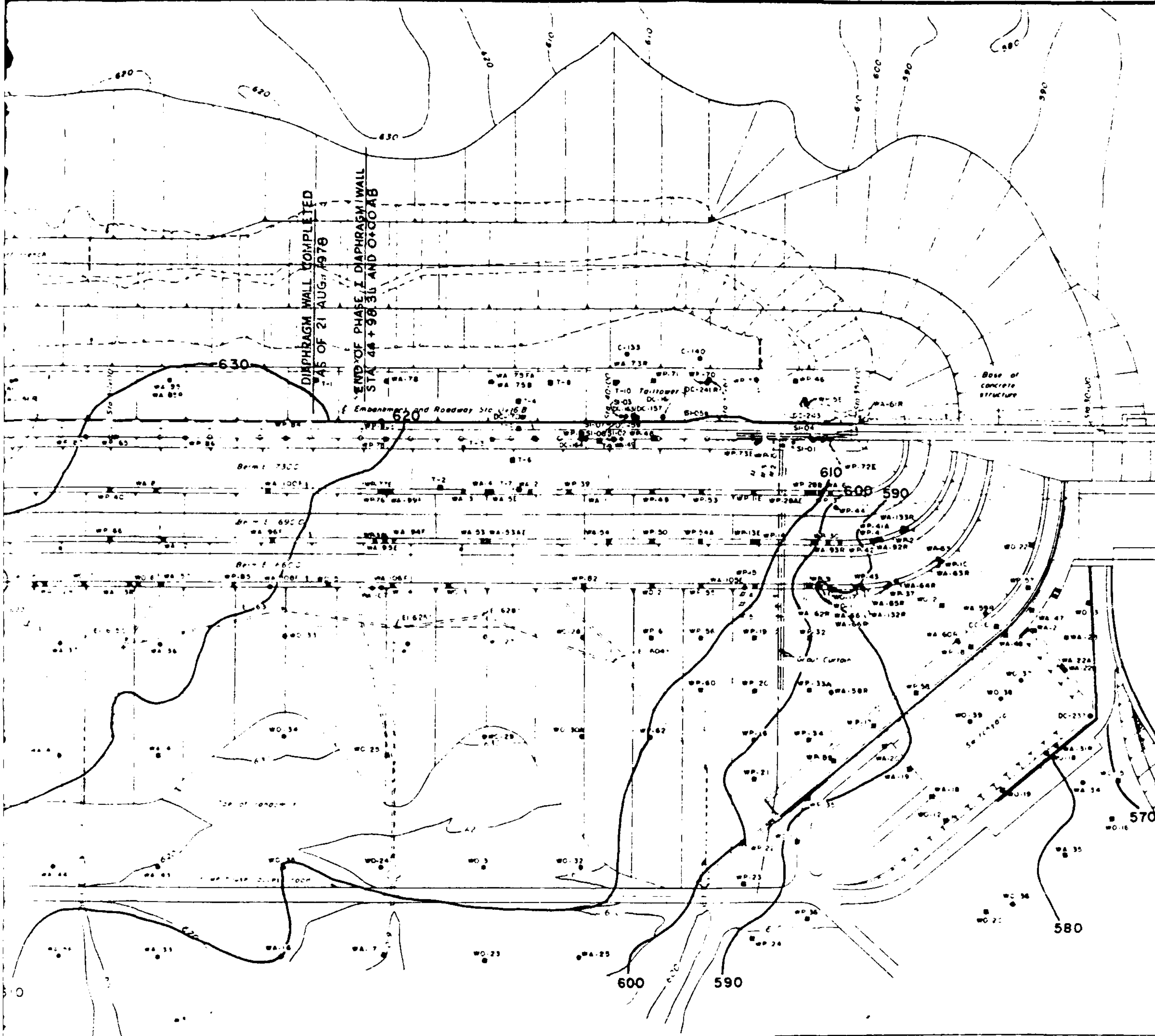
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION

Q2-5



END OF PHASE II DIAPHRAGM WALL
STA. 57+50 L AND O+OOAB
DIAPHRAGM WALL COMPLETED
AS OF 21 AUG., 1978
END OF PHASE I DIAPHRAGM WALL
Toe of random fill
Cut off trench
690
696
670
640
660
650
630
680
620
610
PLAN



PLAN

LEGEND

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- — — — - Diaphragm Wall Under Construction
- ——— - Diaphragm Wall Completed as Of This Date.

GENERAL NOTES

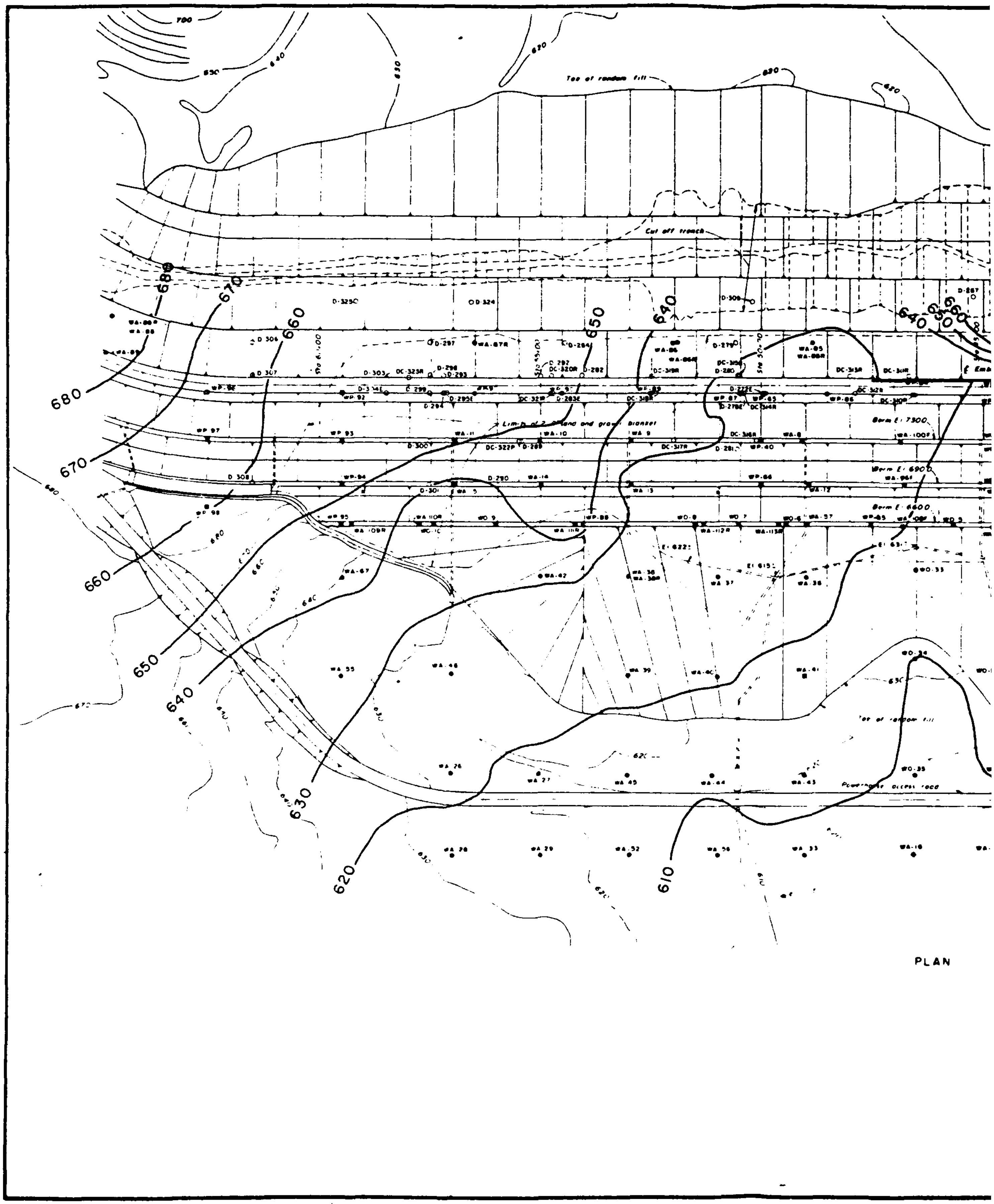
Water level contours are based on piezometer readings made 21 August 1978. Headwater and Tailwater elevations on 21 Aug. 78 are El 705.7 and El 547.0 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS

FAULKENBERRY

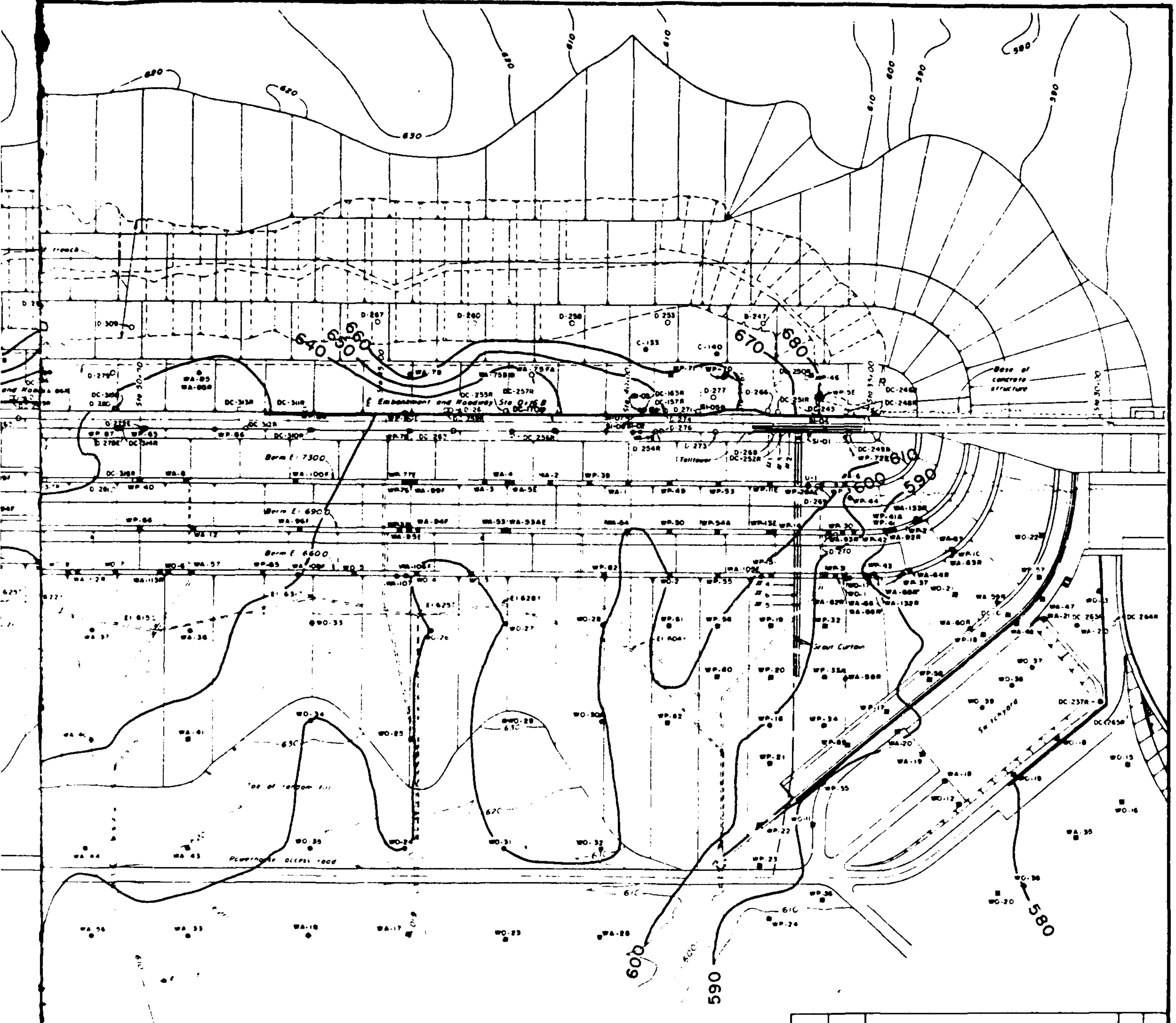
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETER CONTOURS AT TOP ROCK
21, AUG. 1978

SK-2



Toe of random fill
Cut off trench
Toe of random fill
Powerhouse access road
Berm El 7300
Berm El 6900
Berm El 6600
680
670
660
650
640
630
620
610

PLAN



PLAN

LEGEND

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer

GENERAL NOTES

Water level contours are based on piezometer readings made 23 Oct. 1978. Headwater and Tailwater elevations on 23 Oct 78 are El 687.1 and El 548.7 respectively.

1	6 1978	Added Piezometers DC-246 - D-276		

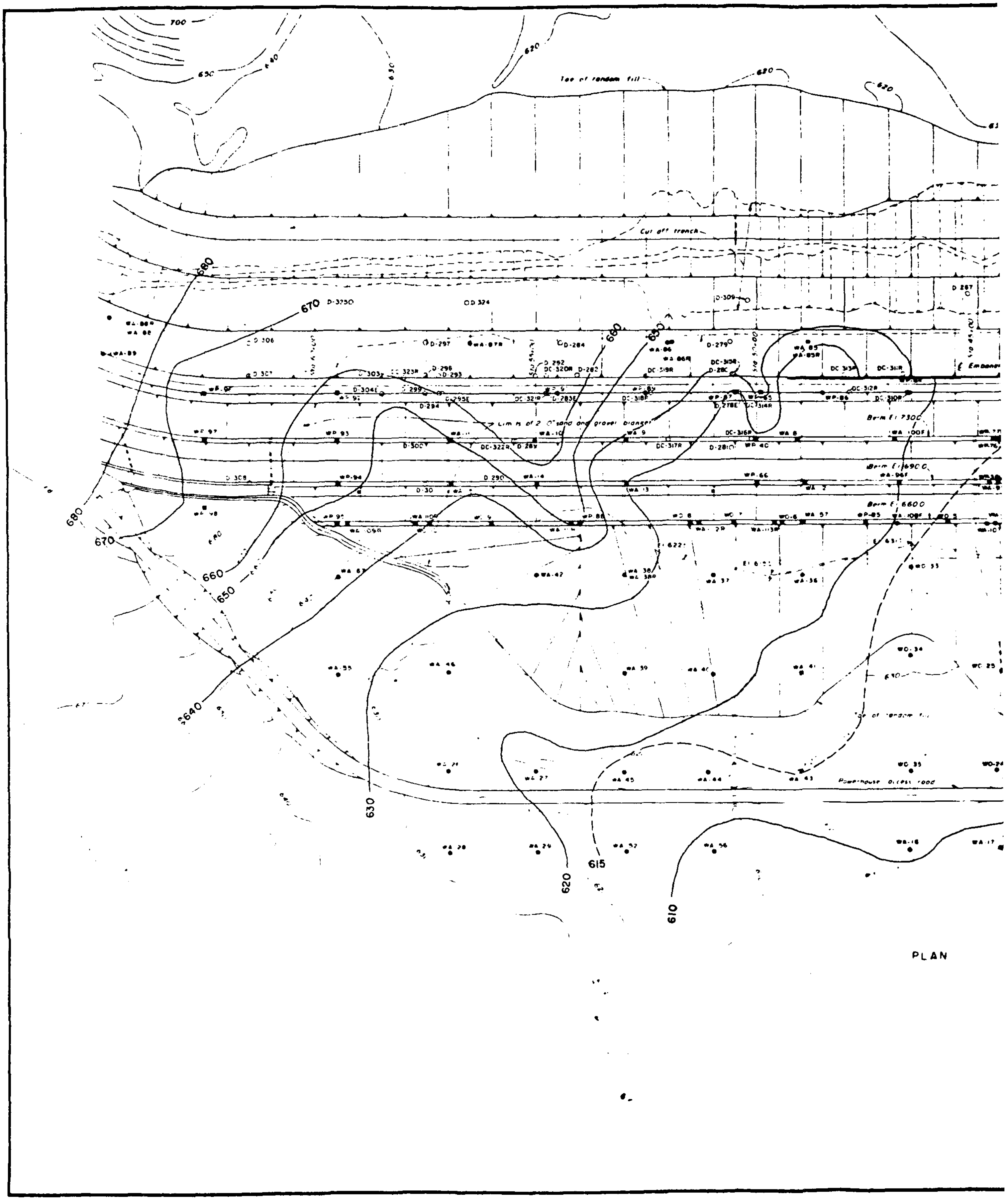
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

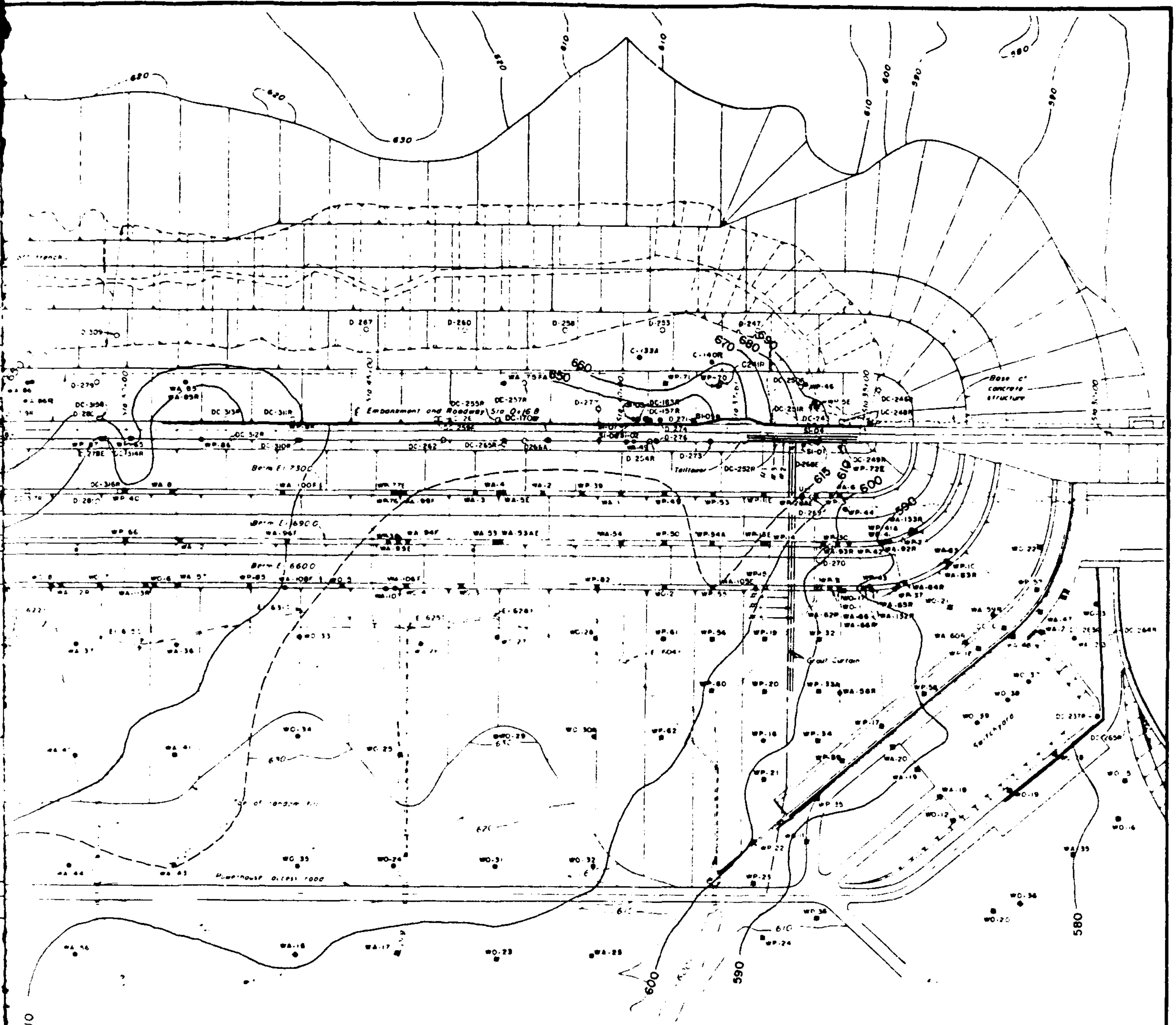
FAULKENBERRY

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
23 OCT 1978

CHIEF, GEOTECHNICAL BRANCH

02-5


700
650
640
630
620
Toe of random fill
Cut off trench
670
660
680
650
640
630
620
615
610
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Toe of random fill
Powerhouse access road
PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES.

Water level contours are based on piezometer readings made 20 February 1979. Headwater and Tailwater elevations on 20 Feb 79 are El 711.6 and El 559.6 respectively.

2	3-1-79	UPDATED PIEZOMETER LOCATIONS		
		Added Piezometers DC-246 - D-27		
REVISION	DATE	DESCRIPTION	BY	CHKD

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT CORPS OF ENGINEERS

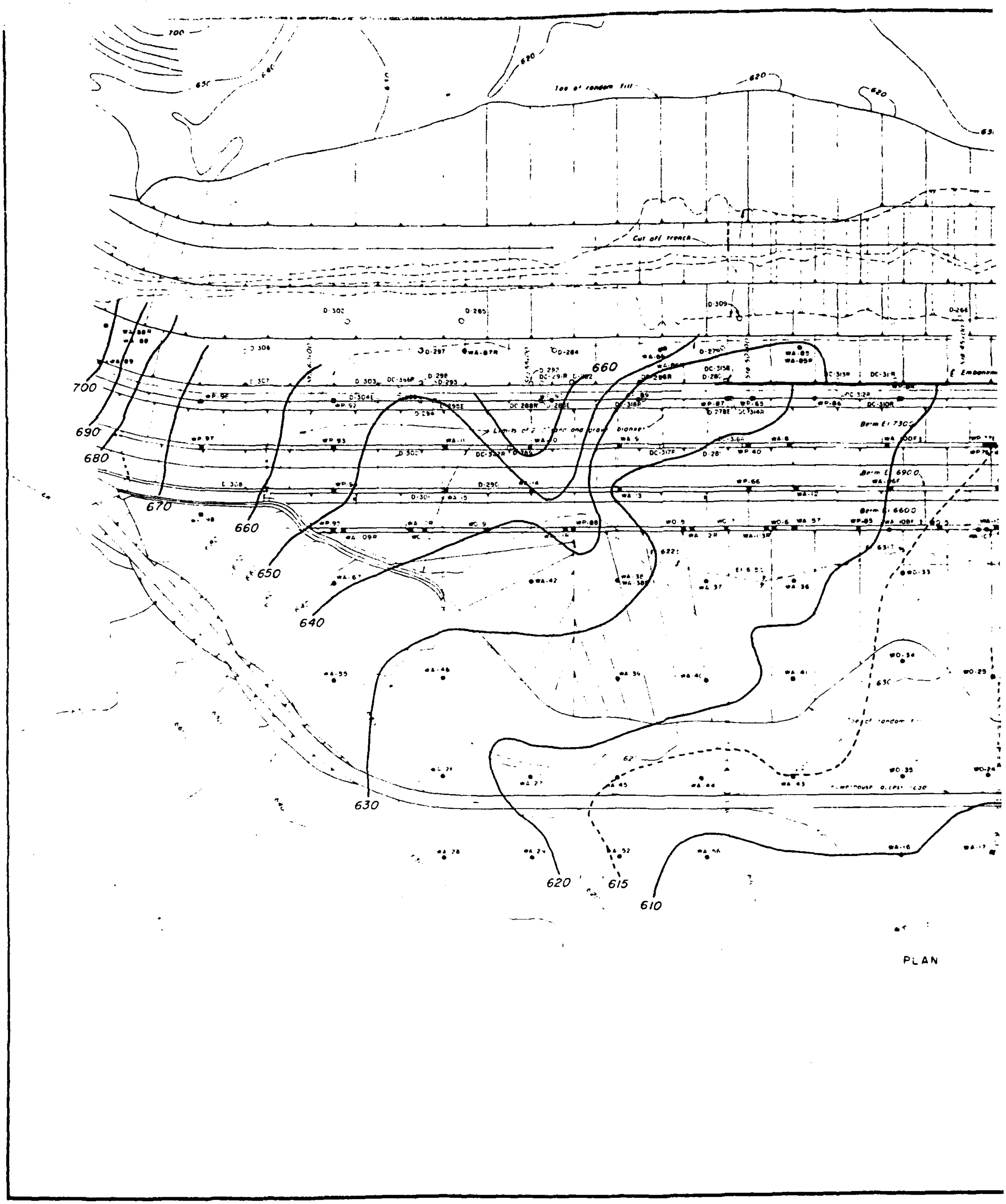
GSS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
20 FEBRUARY 1979

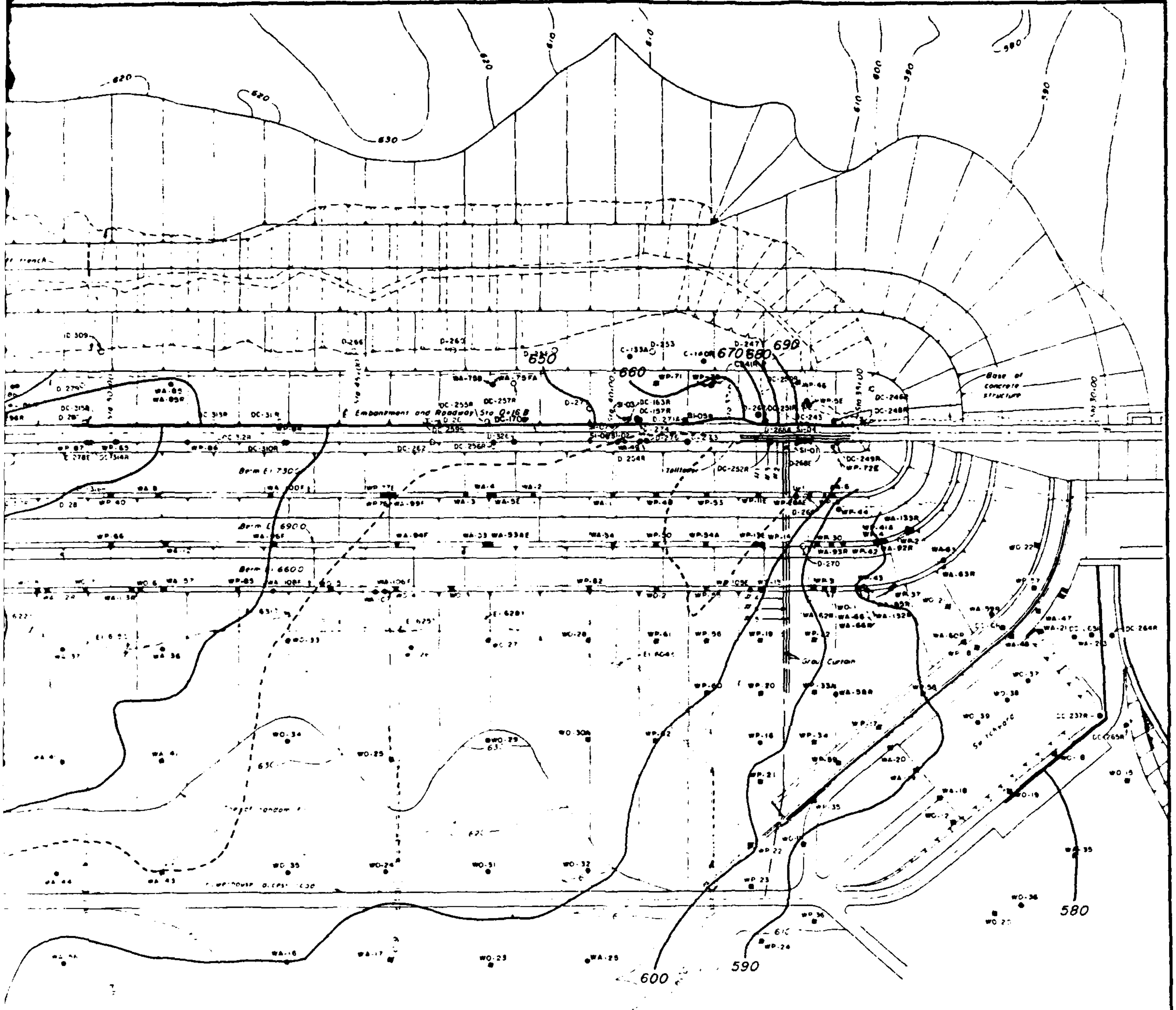
CHIEF, GEOTECHNICAL BRANCH

Q2-5

PLATE B- 23



Toe of random fill
Cut off trench
700
690
680
670
660
650
640
630
620
615
610
Berm El 6900
Berm El 6600
PLAN



PLAN

LEGEND

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer

GENERAL NOTES:

Water level contours are based on piezometer readings made 23 July 1979. Headwater and Tailwater elevations on 23 July '79 are El 720.9 and El 544.7 respectively.

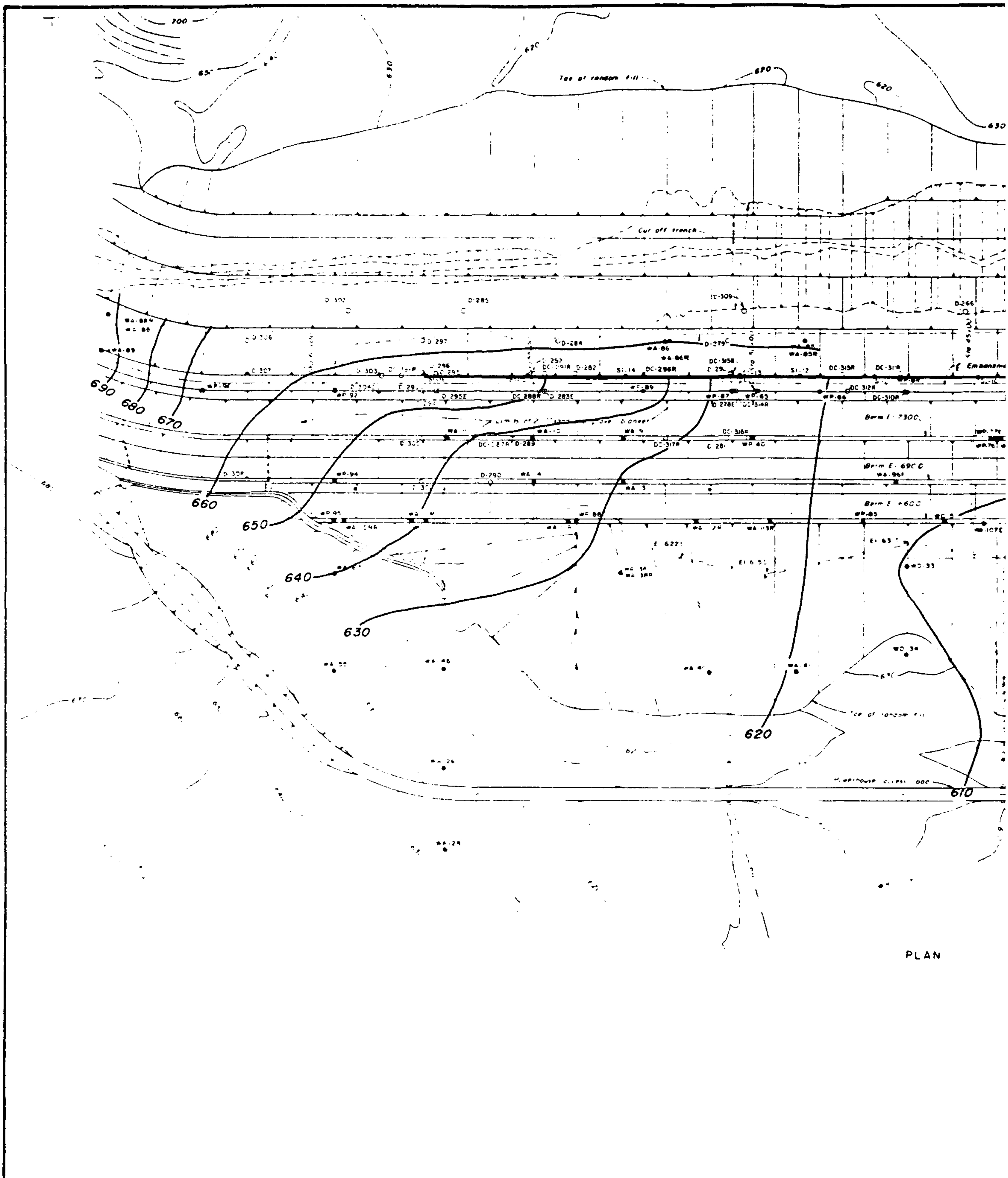
REVISION	DATE	DESCRIPTION
2	3-1-79	UPDATED PIEZOMETER LOCATIONS
1	10-15-76	Added Piezometers DC-246 - D-276

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

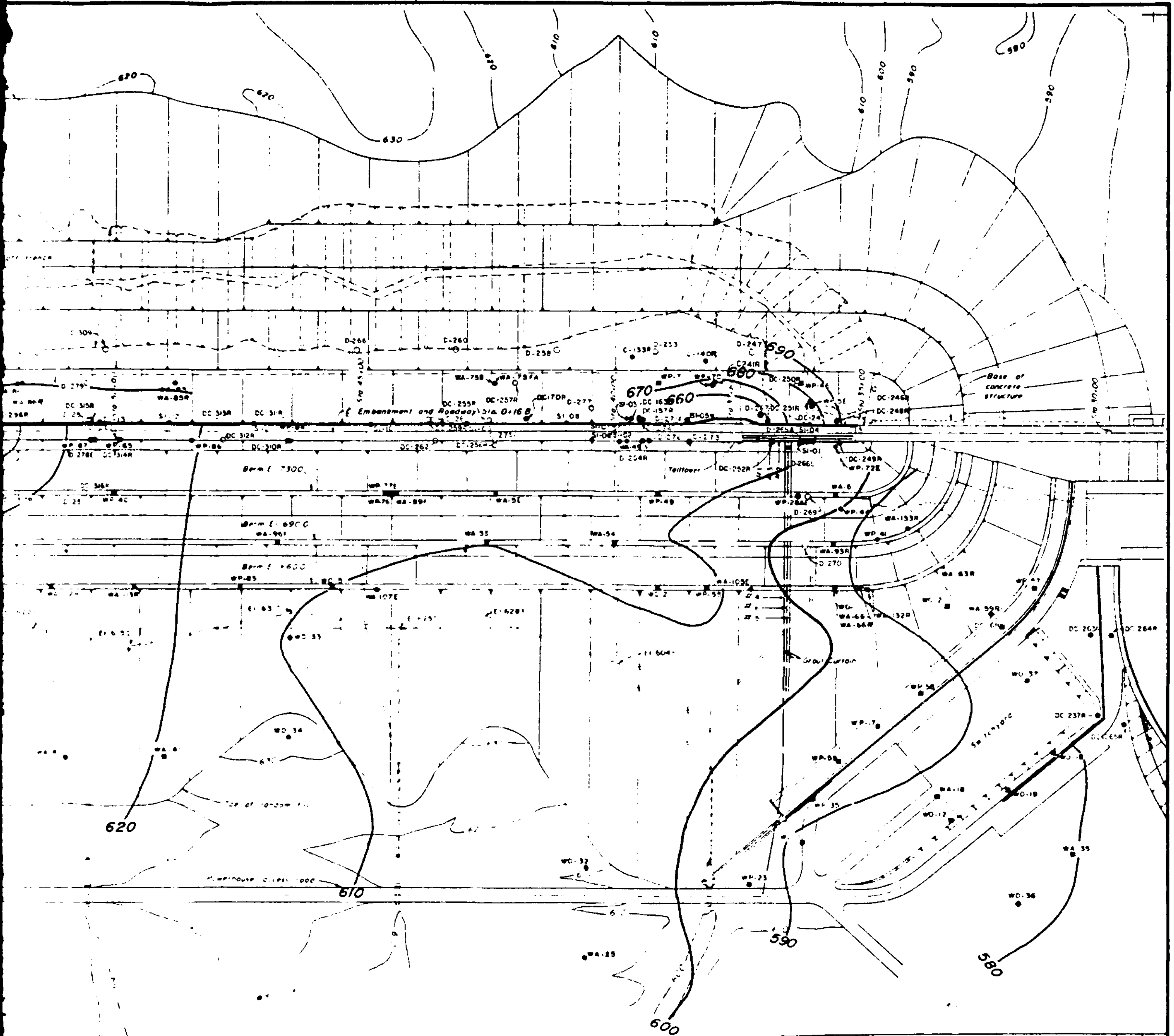
CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
23 July 1979

Q2-5

PLATE B- 24



Toe of random fill
Cut off trench
Berm El 7300
Berm El 6900
Berm El 6600
690
680
670
660
650
640
630
620
610
PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

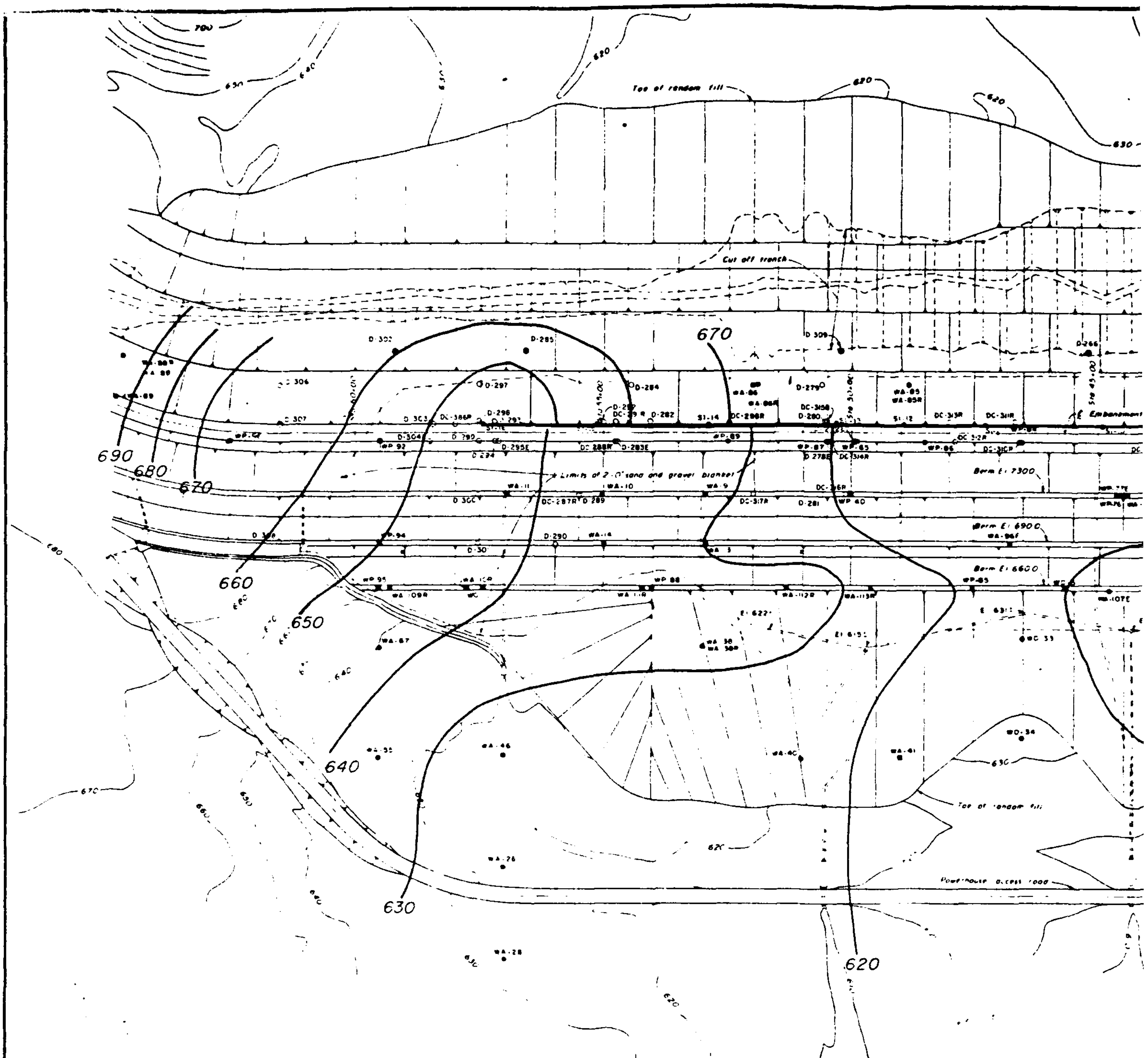
Water level contours are based on piezometer readings made 26 NOV 1979. Headwater and Tailwater elevations on 26 NOV are El 704.4 and El 556.7 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETER CONTOURS AT TOP OF ROCK
26 NOVEMBER 1979

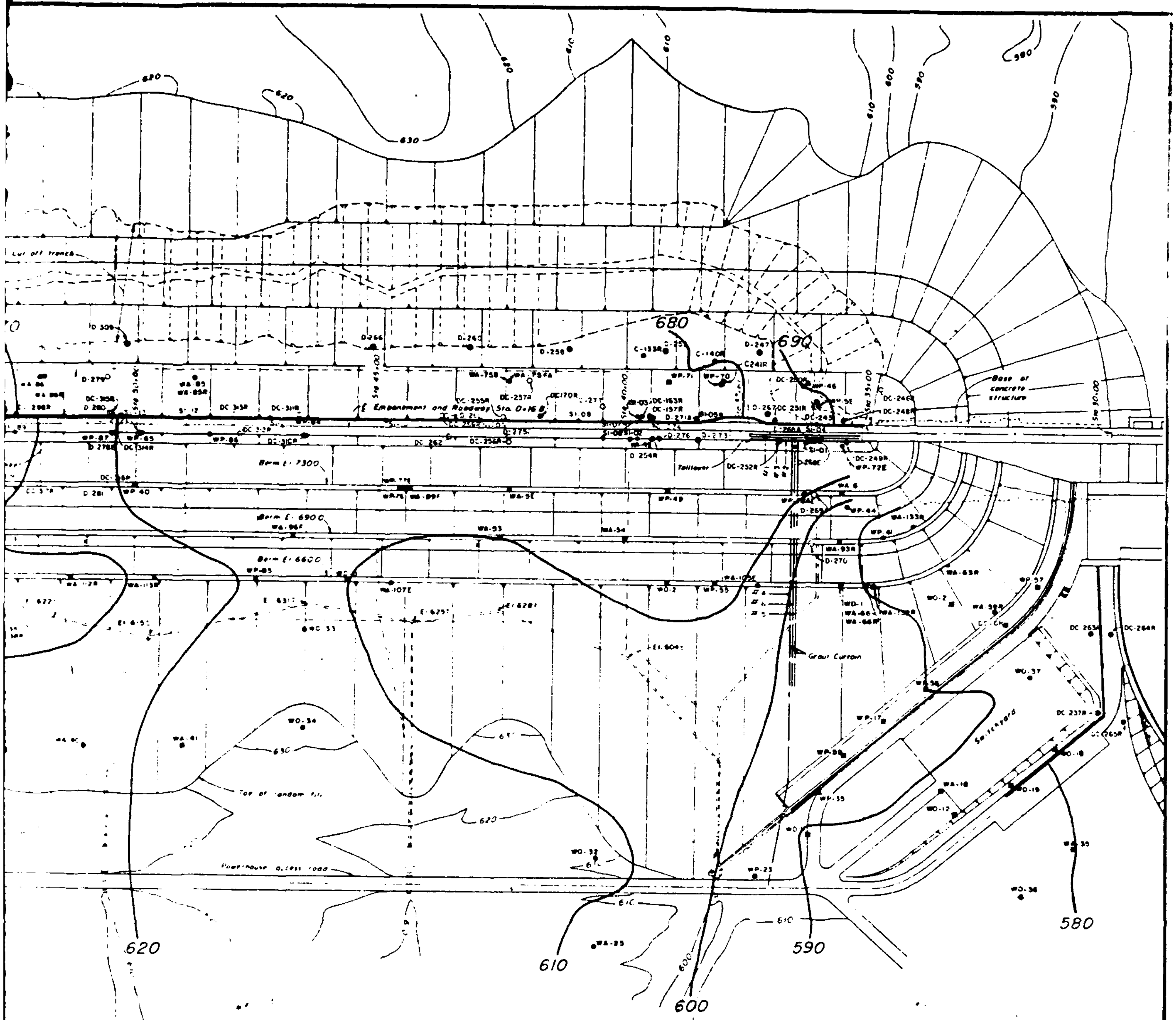
CHIEF, GEOTECHNICAL BRANCH

02-5



Toe of random fill
Cut off trench
Limits of 2.0' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Toe of random fill
Powerhouse access road
Embankment
690
680
670
660
650
640
630
620
670

PLAN



PLAN

LEGEND

WA-33E - Embankment Piezometer
WA-33F - Filter Piezometer
WA-33 - Top of Rock Piezometer
WA-33R - Bedrock Piezometer

GENERAL NOTES:

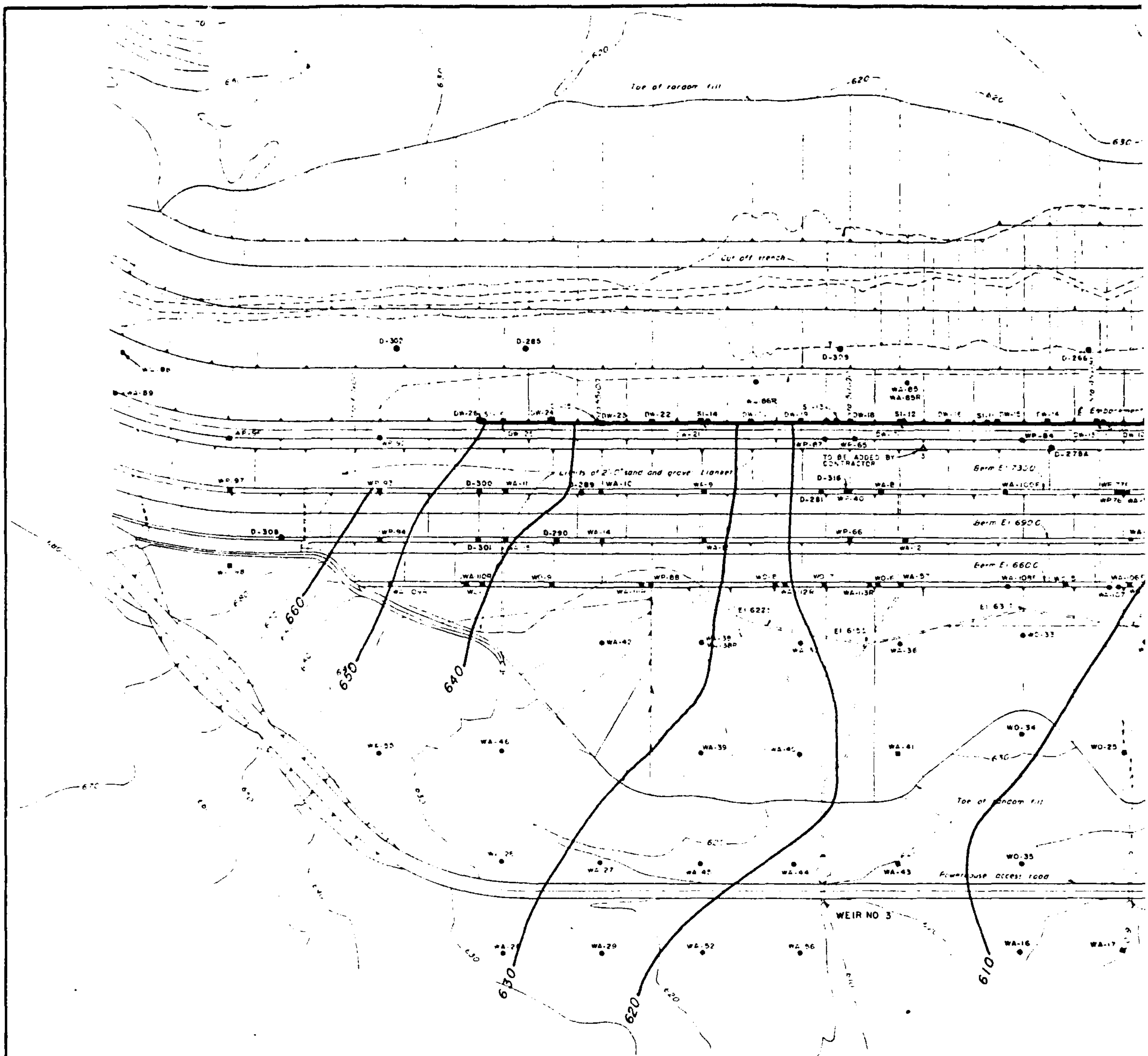
Water level contours are based on piezometer readings made 10 March 1980 Headwater and Tailwater elevations on 10Mar80 are El. 711.07 and El 554.56 respectively

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIZOMETRIC CONTOURS AT TOP OF ROCK
10 MARCH 1980

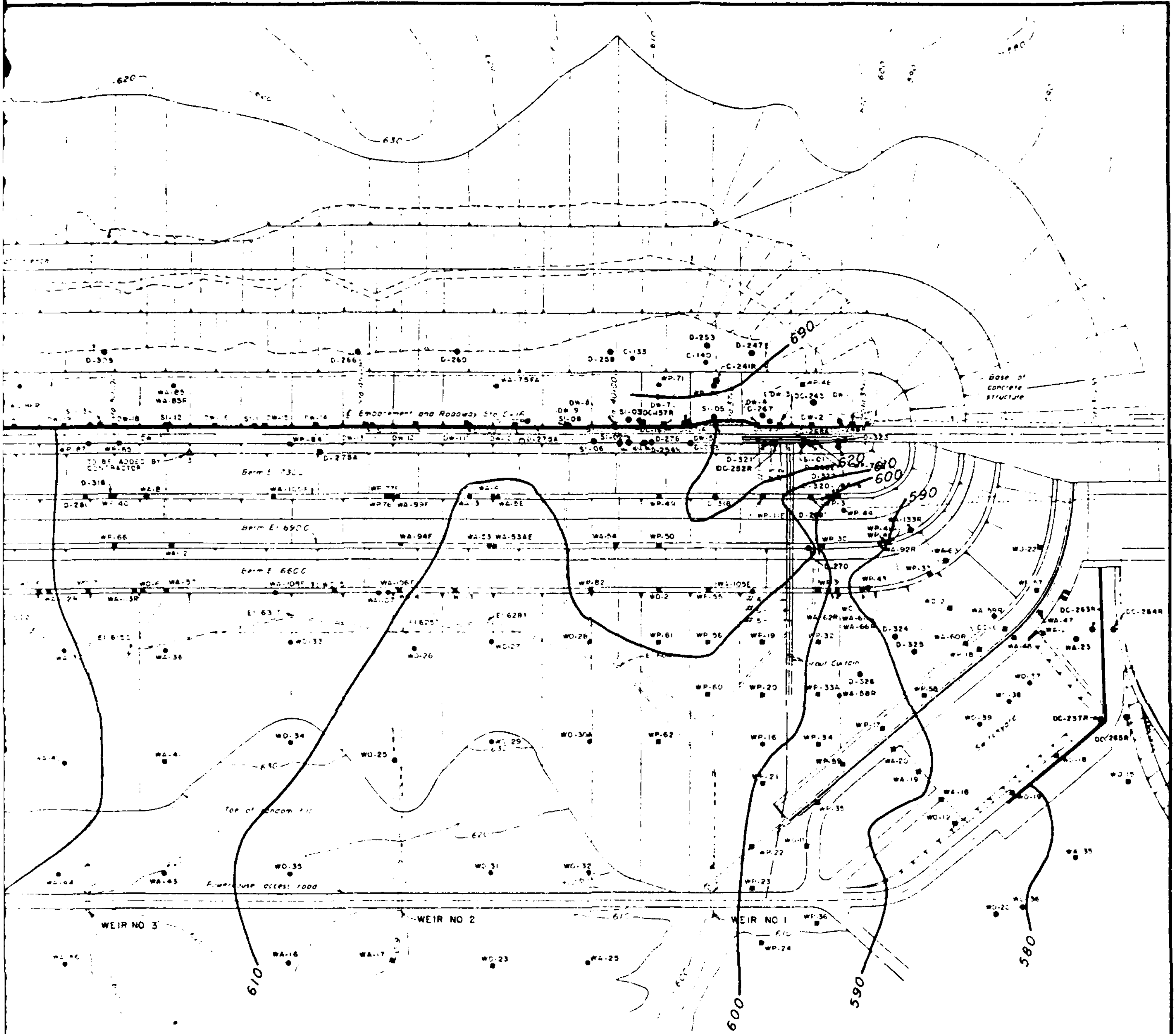
CHIEF, GEOTECHNICAL BRANCH

02-6



Toe of random fill
Cut off trench
Berm El 7300
Berm El 6900
Berm El 6600
WEIR NO 3
Powerhouse access road
660
650
640
630
620
610

PLAN



LEGEND
- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- SI-03 - Inclinometer
- ■ Monumentation
- ▲ Seismic Instrument

GENERAL NOTES
Water Level Contours are Based on Piezometer Readings Made 1 June 1981. Headwater and Tailwater Elevations on 1 June 1981 are El 722.2 and El 559.6 Respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

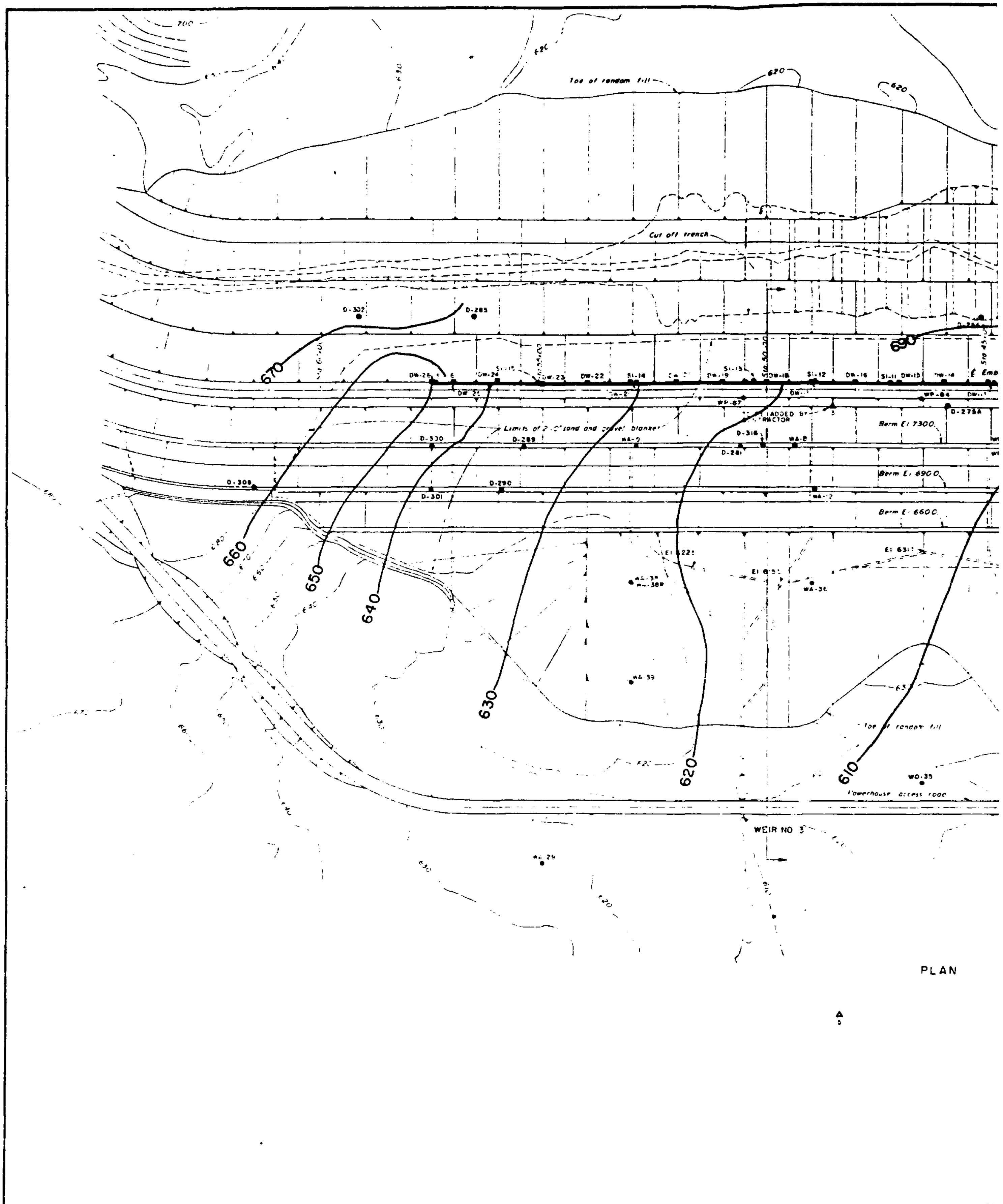
GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

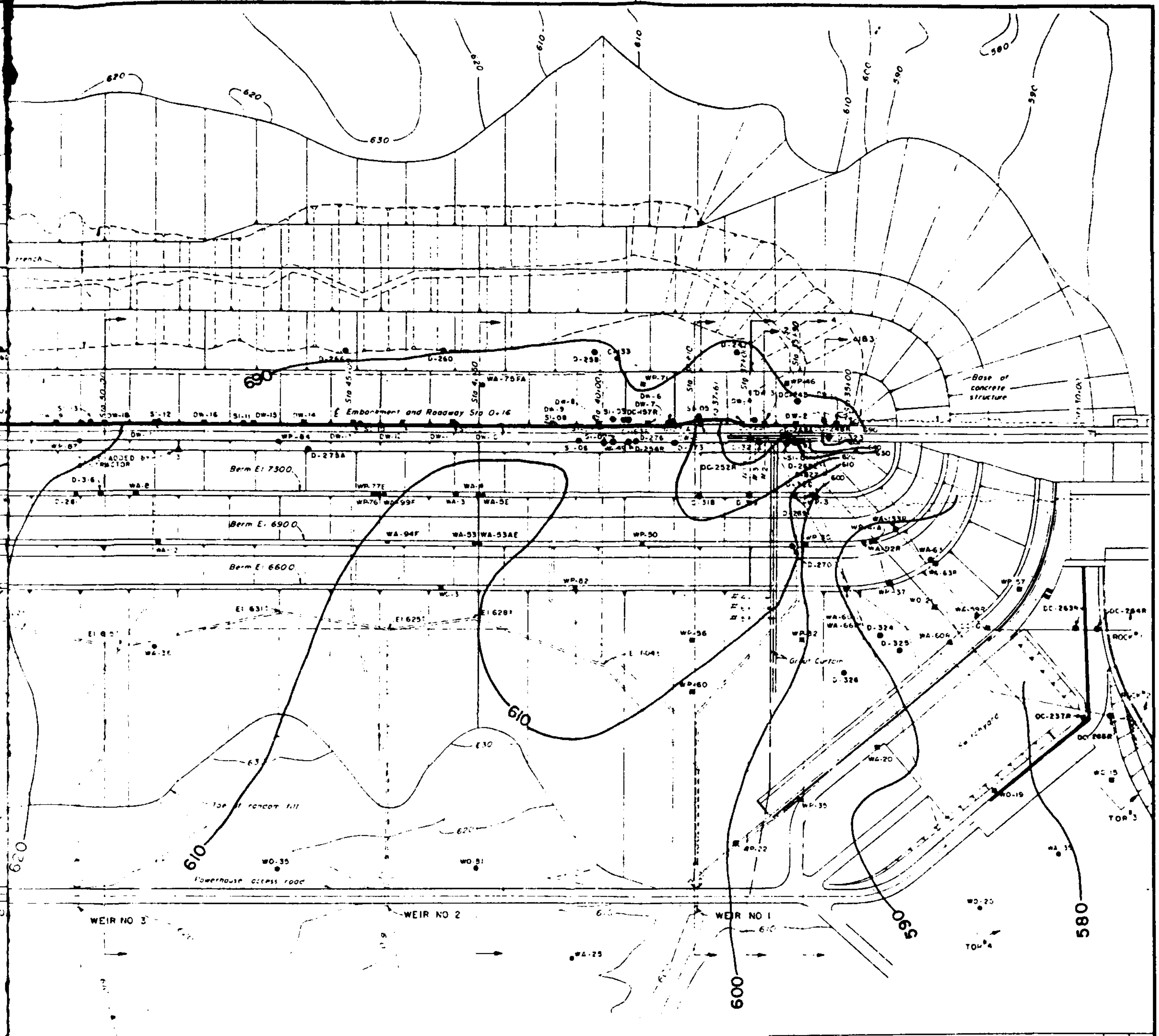
DRAWN
CHECKED
TRACED
COMPARED

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
PIEZOMETER CONTOURS AT TOP OF ROCK
1 JUNE 1981

SUBMITTED
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
DATE
SCALE
SPEC. NO.
DRAWING NUMBER
SHEET OF


Toe of random fill
Cut off trench
D-302
D-285
670
690
DW-26
DW-24
DW-23
DW-22
SI-14
SI-12
DW-16
DW-15
WP-87
WP-84
D-275A
Limits of 2.0' sand and gravel blanket
Berm El 7300
D-330
D-289
WA-2
D-316
WA-8
D-281
D-306
D-290
D-301
Berm El 6900
Berm El 6600
660
650
640
630
620
610
El 622
El 631
WA-36
WA-39
Toe of random fill
WO-35
Powerhouse access road
WEIR NO 3
700

PLAN



PLAN

LEGEND

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- SI 03 - Inclinometer
- ■ Monumentation
- △ Seismic Instrument

GENERAL NOTES

Water level contours are based on piezometer readings made 4 Oct 1982. Headwater and Tailwater elevations on 4 Oct '82 are El 694.87 and El 552.87 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

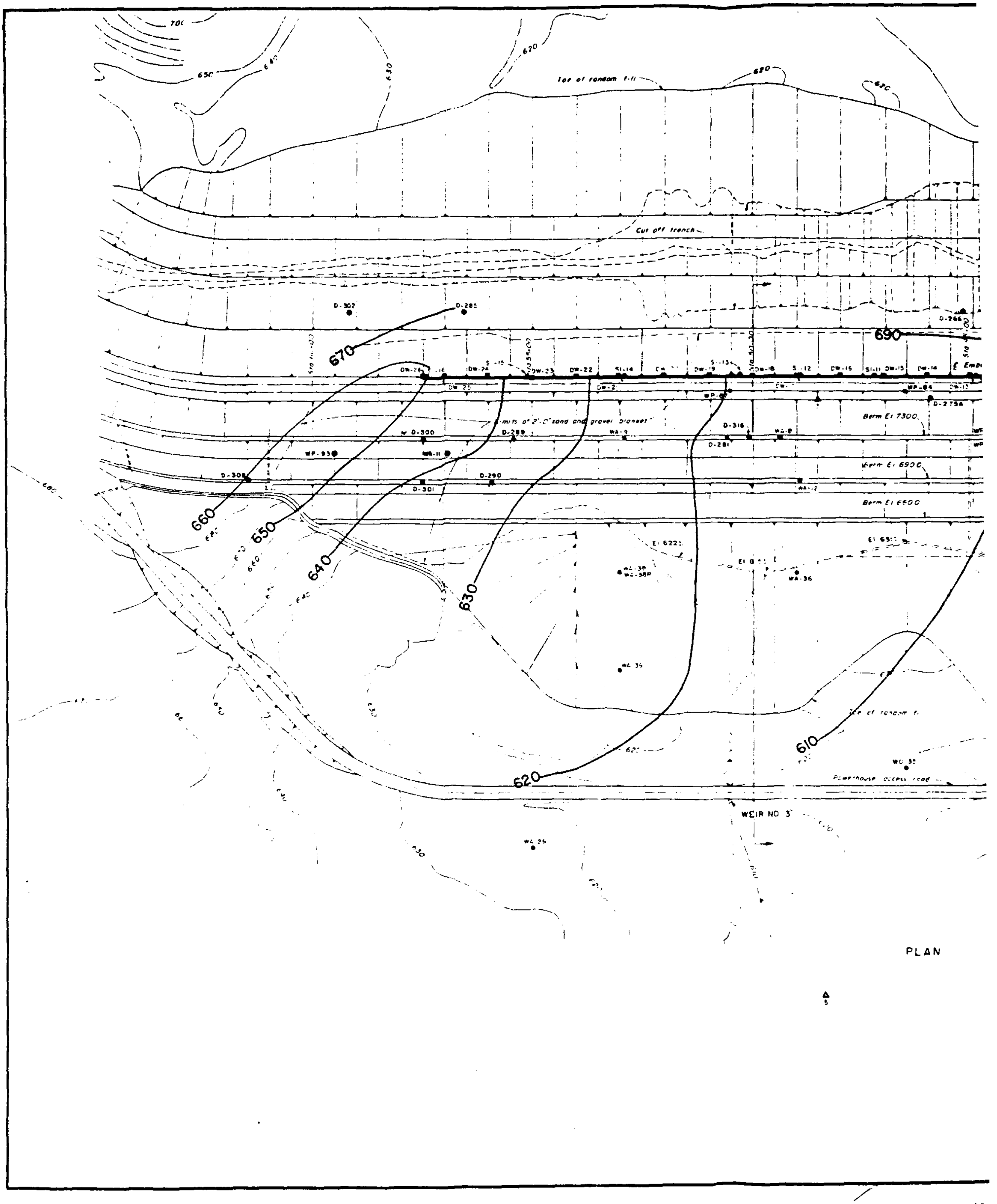
DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

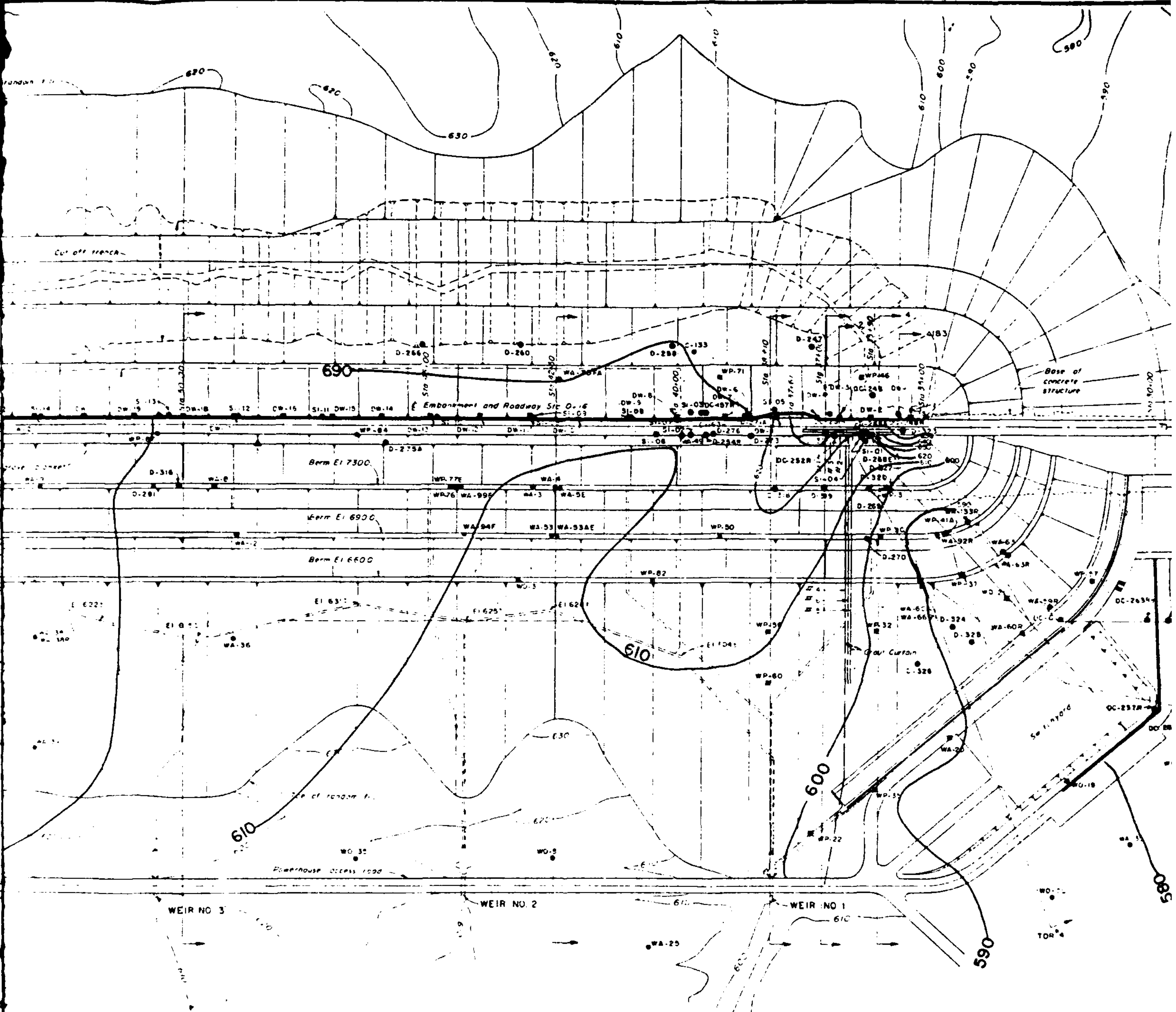
DRAWN
CHECKED
TRACED
COMPARED
ENGINEER

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

INTRUMENTATION PLAN

SUBMITTED
CHIEF, GEOTECHNICAL BRANCH
APPROVAL RECOMMENDED
CHIEF, ENGINEERING DIVISION
APPROVED
COLONEL, C.E. DISTRICT ENGINEER
DATE
SCALE 1" = 100'
SPEC. NO
DRAWING NUMBER
SHEET OF
02-


Toe of random fill
Cut off trench
Limits of 2'-0" sand and gravel blanket
Berm El 7300
Berm El 6900
Berm El 6600
El 622
WEIR NO 3
Powerhouse access road
Toe of random f.
D-302
D-285
D-300
D-289
D-290
D-301
D-308
WP-93
WA-11
WA-9
WA-8
WA-12
WA-36
WA-39
WA-29
D-316
D-281
D-266
DW-26
DW-24
DW-23
DW-22
DW-18
DW-16
DW-14
S-12
670
660
650
640
630
620
610
690
PLAN



PLAN

LEGEND:

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- ● SI 03 - Inclinometer
- ■ Monumentation
- ▲ Seismic Instrument
- ∿ - Water Level Contour Line

GENERAL NOTES

Water level contours are based on piezometer readings made 6 Sept 1983. Headwater and Tailwater elevations on 6 Sept' 83 are El 692.58 and El 559.26 respectively.

REVISION	DATE	DESCRIPTION

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

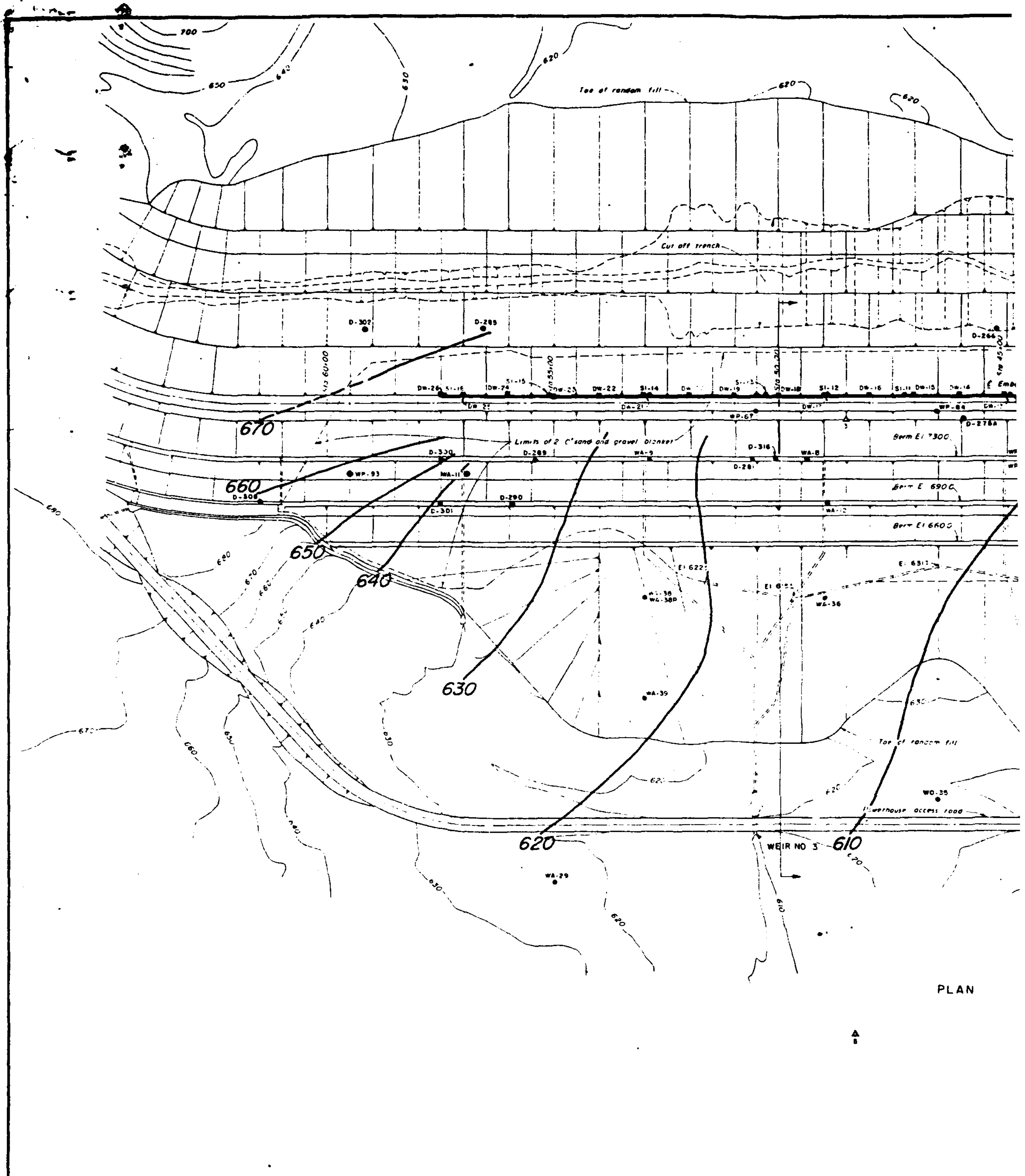
INTRUMENTATION PLAN

CHIEF, GEOTECHNICAL BRANCH

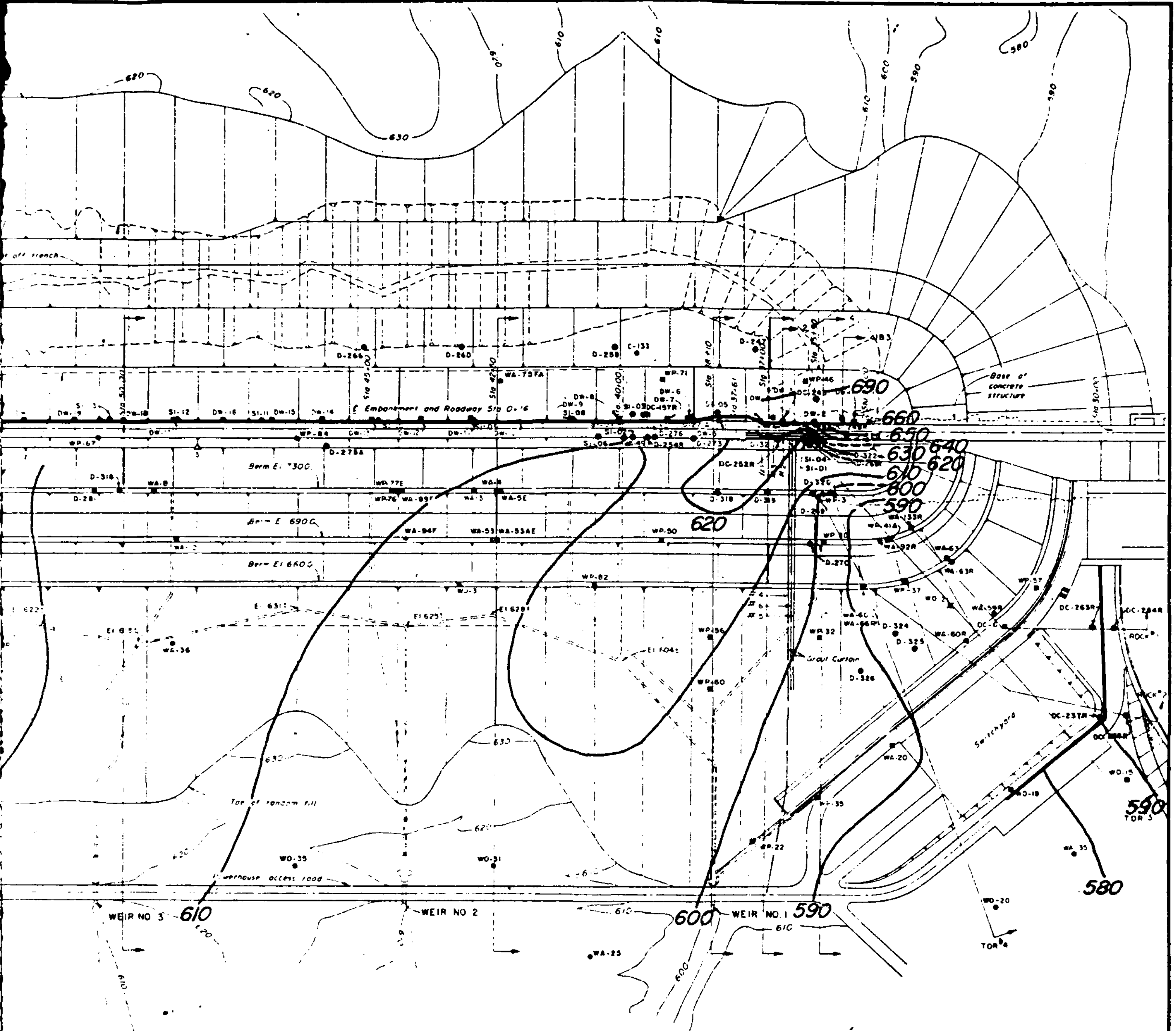
COLONEL, C. E. DISTRICT ENGINEER

02-

PLATE B-



Toe of random fill
Cut off trench
Limits of 2 C' sand and gravel blanket
Berm El 730.0
Berm El 690.0
Berm El 660.0
Toe of random fill
Powerhouse access road
WEIR NO 3
670
660
650
640
630
620
610
PLAN



PLAN

LEGEND:

- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- SI-03 - Inclinometer
- Monumentation
- Seismic Instrument

GENERAL NOTES:

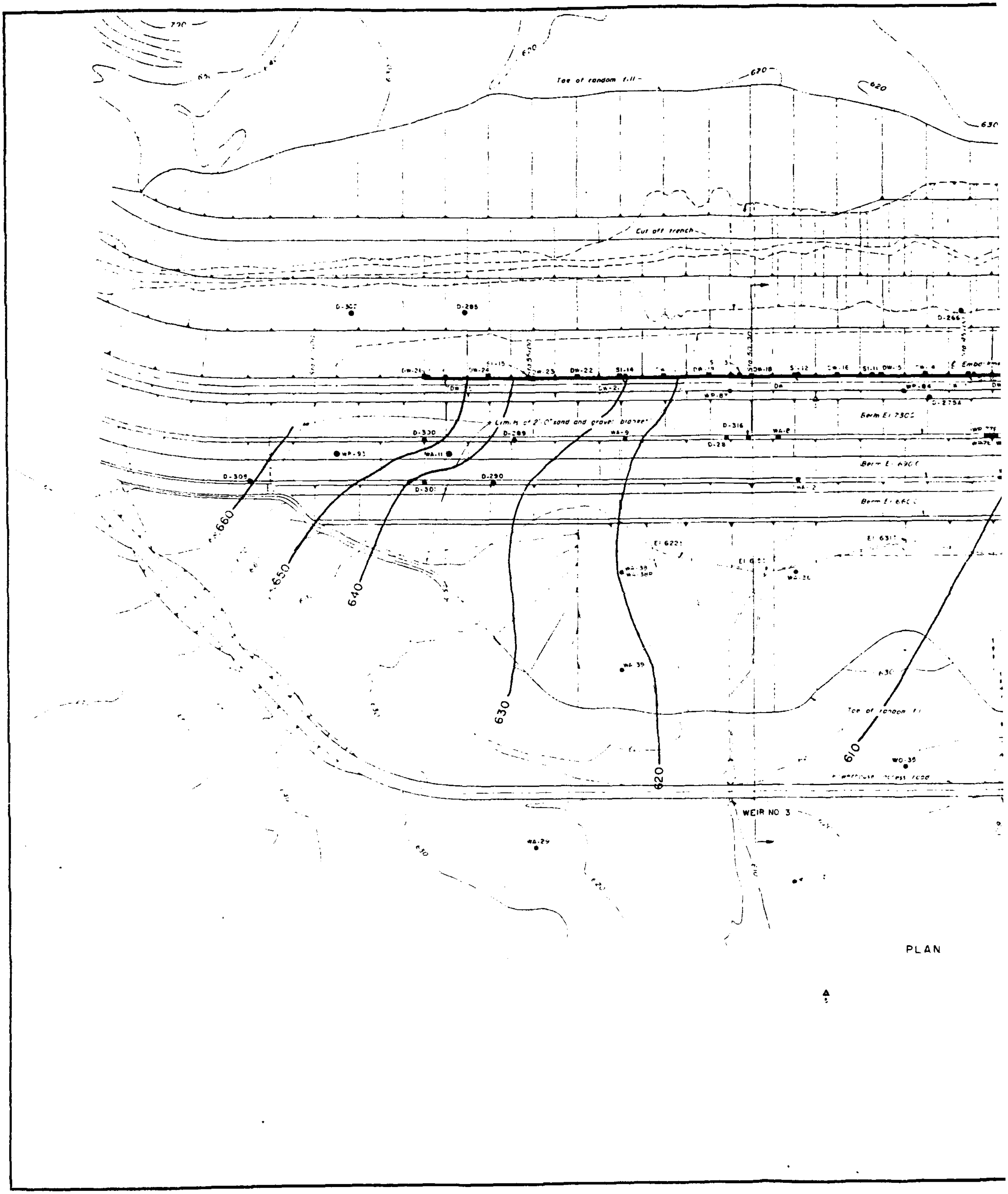
Water level contours are based on piezometer readings made 4 Sept. 1984. Headwater and Tailwater elevations on 4 Sept 1984 are El 701.65 and El 556.17 respectively.

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM
INSTRUMENTATION AND MONUMENTATION
PIEZOMETRIC CONTOURS AT TOP OF ROCK
4 SEPTEMBER 1984

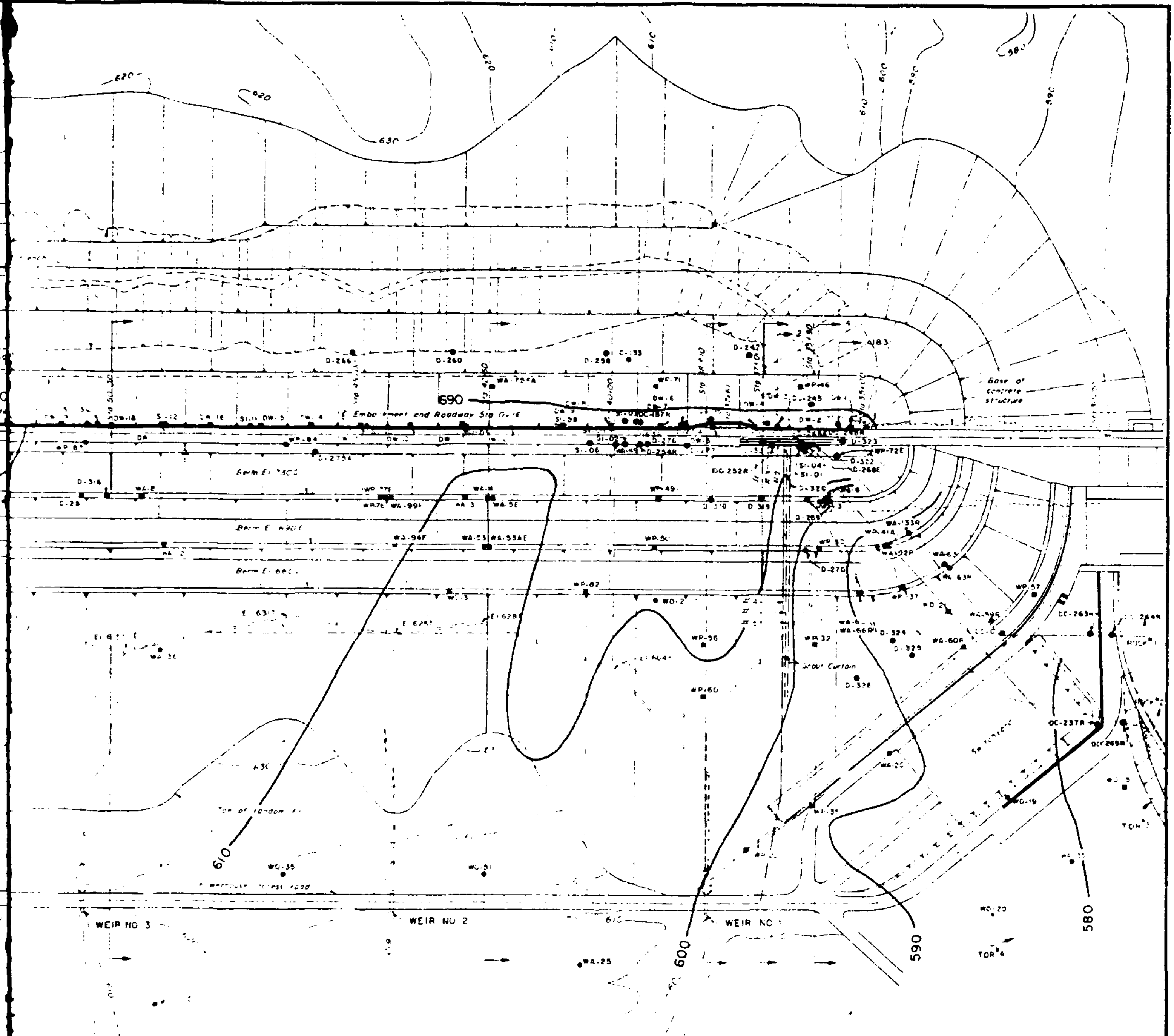
SCALE 1" = 100'

Q2-



Toe of random fill
Cut off trench
D-285
Berm El 730
Berm El 690
Berm El 680
660
650
640
630
620
610
WEIR NO 3
Toe of random fill
Powerhouse access road

PLAN



LEGEND
- WA-33E - Embankment Piezometer
- WA-33F - Filter Piezometer
- WA-33 - Top of Rock Piezometer
- WA-33R - Bedrock Piezometer
- S-03 - Inclinometer
- ■ Monumentation
- Δ Seismic instrument

GENERAL NOTES:

Water level contours are based on piezometer readings made 3 June 1985. Headwater and Tailwater elevations on 3 June '85 are El 716.00 and El 550.07 respectively.

REVISION	DATE	DESCRIPTION	BY	CHKD

GRAPHIC SCALE

DEPARTMENT OF THE ARMY
NASHVILLE DISTRICT, CORPS OF ENGINEERS
NASHVILLE, TENNESSEE

CUMBERLAND RIVER WATERSHED
WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER, KENTUCKY
DAM

INSTRUMENTATION PLAN

DRAWN / CHECKED / TRACED / COMPARED / ENGINEER

SUBMITTED / APPROVAL RECOMMENDED / CHIEF ENGINEERING DIVISION

APPROVED / COLONEL, C.E. DISTRICT ENGINEER

SCALE 1:100 / SPEC NO / DRAWING NUMBER

DATE / SHEET OF / Q2-

PLATE B- 31

EMBANKMENT WEIR PLOTS

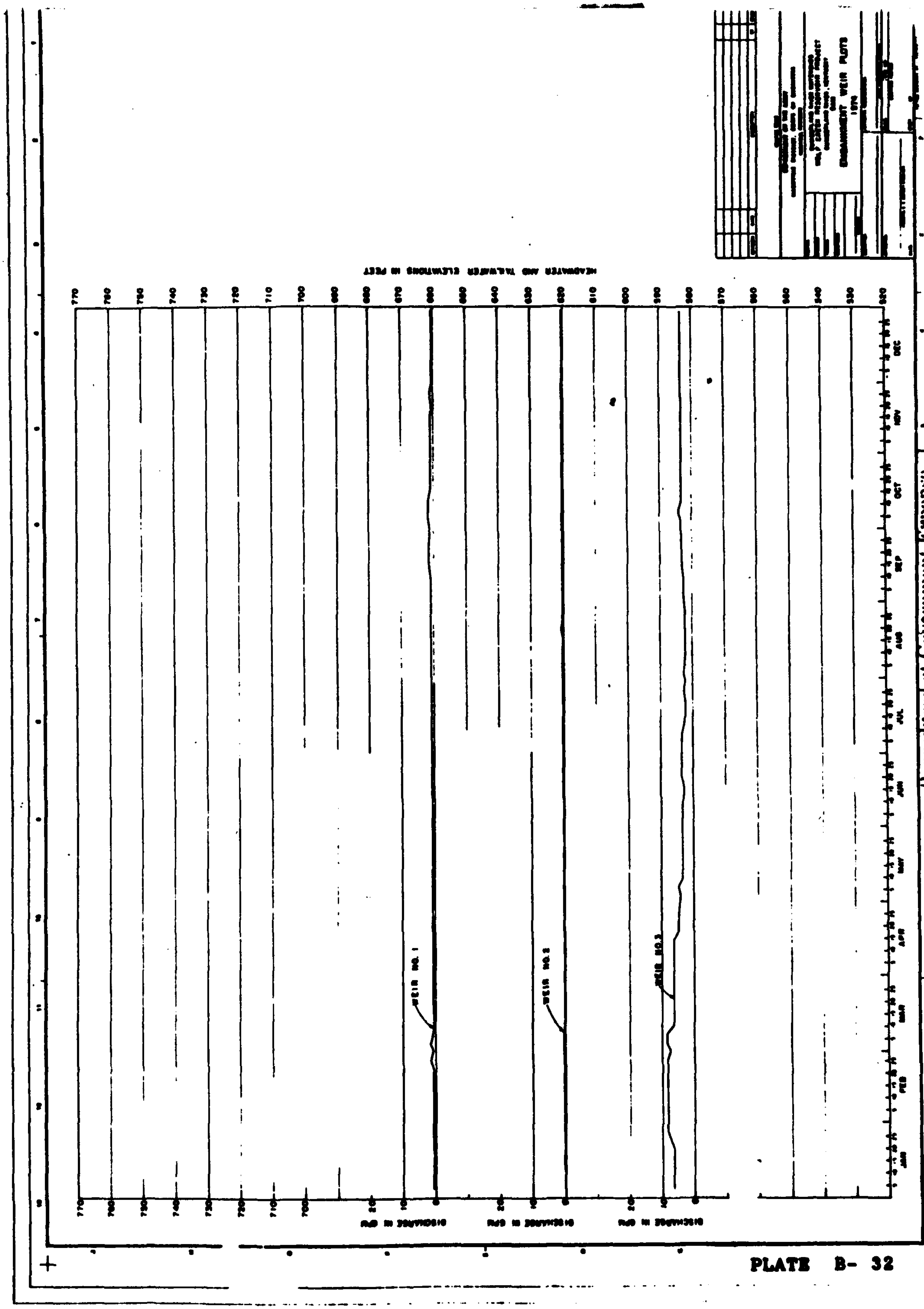

EMBANKMENT WEIR PLOTS
1974
HEADWATER AND TAILWATER ELEVATIONS IN FEET
DISCHARGE IN GPM
WEIR NO. 1
WEIR NO. 2
WEIR NO. 3
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

PLATE B- 32

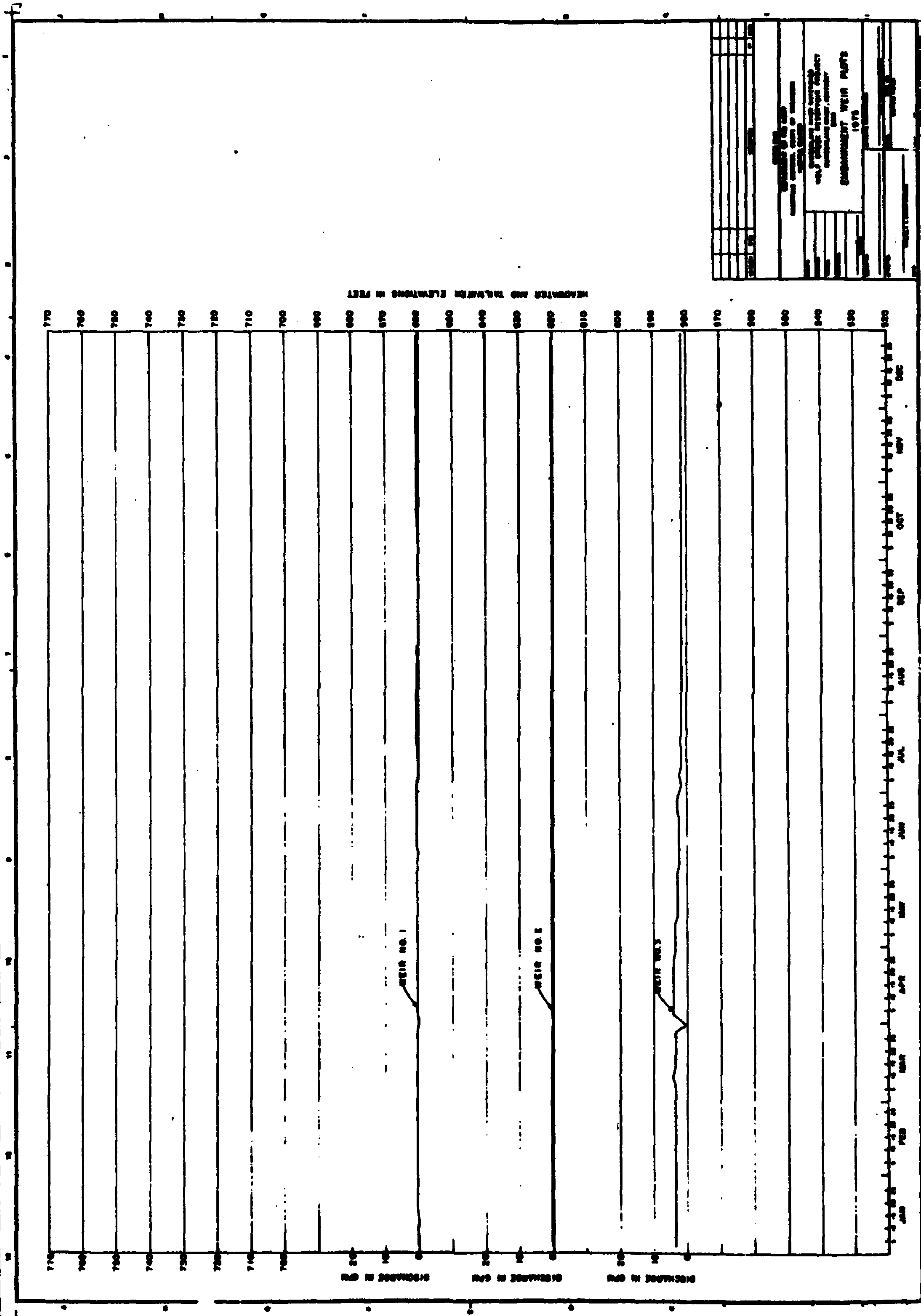

EMBANKMENT WEIR PLOTS
HEADWATER AND TAILWATER ELEVATIONS IN FEET
WEIR NO. 1
WEIR NO. 2
WEIR NO. 3
DISCHARGE IN GPM
DISCHARGE IN GPM
DISCHARGE IN GPM

PLATE B- 33

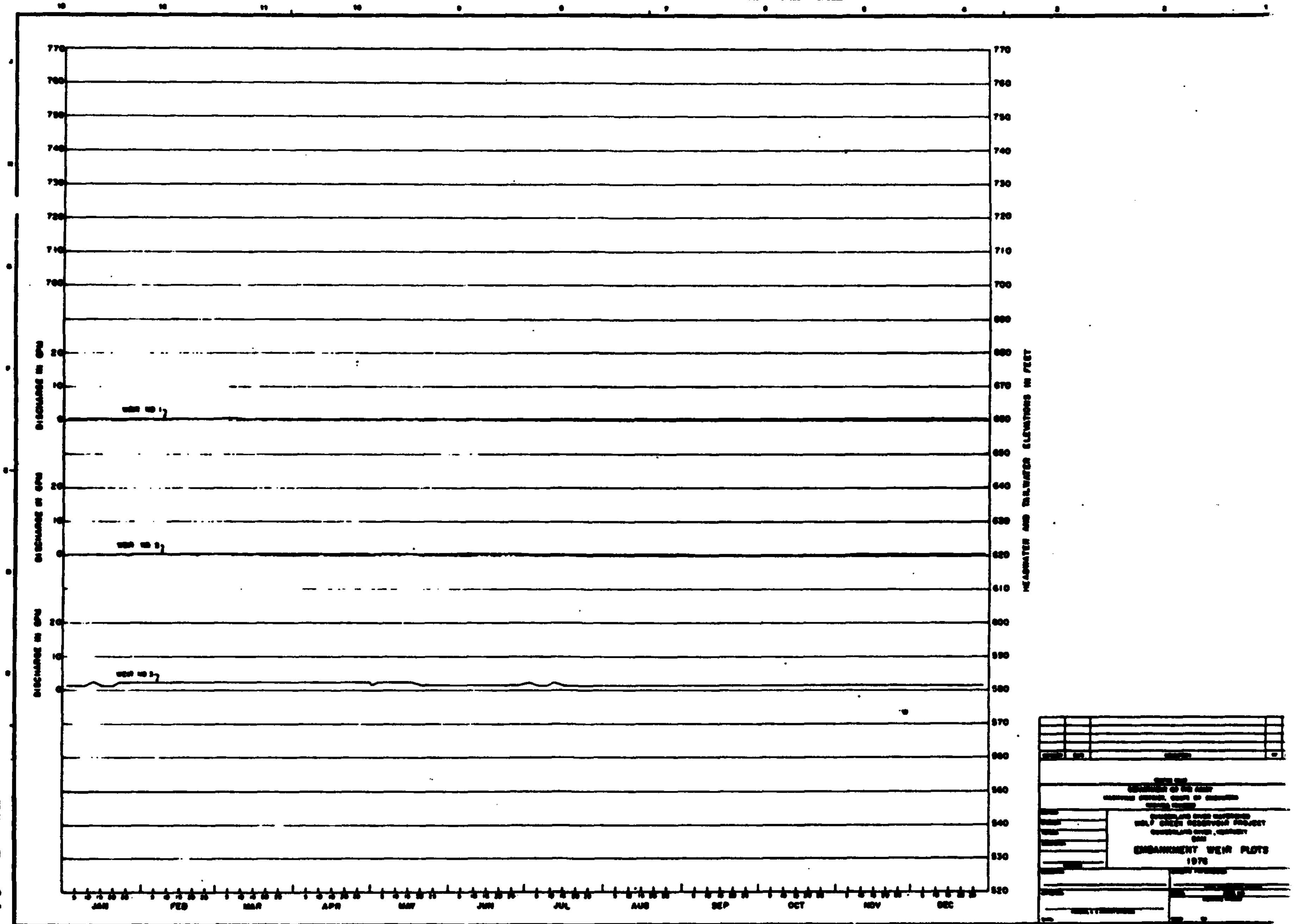
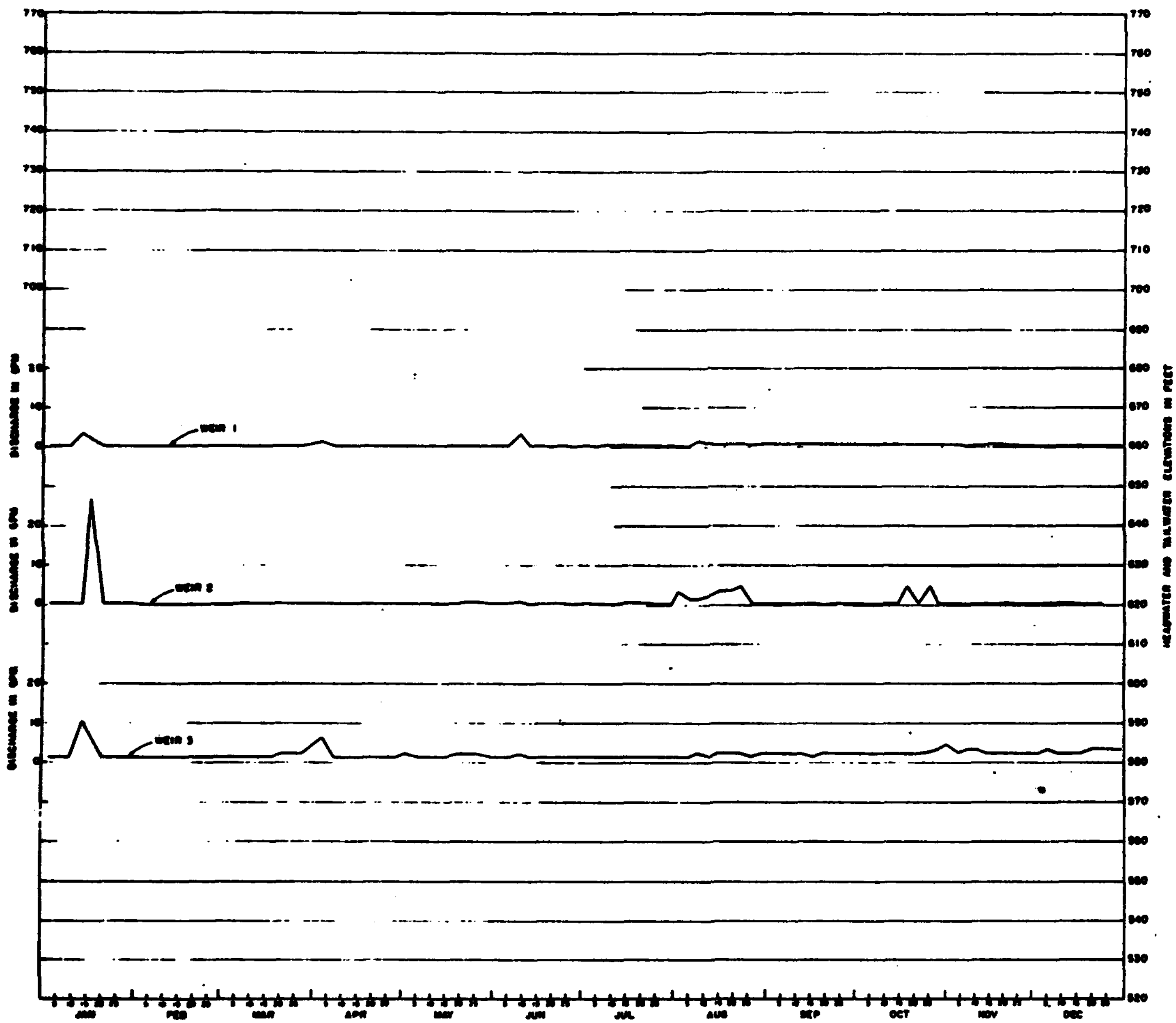
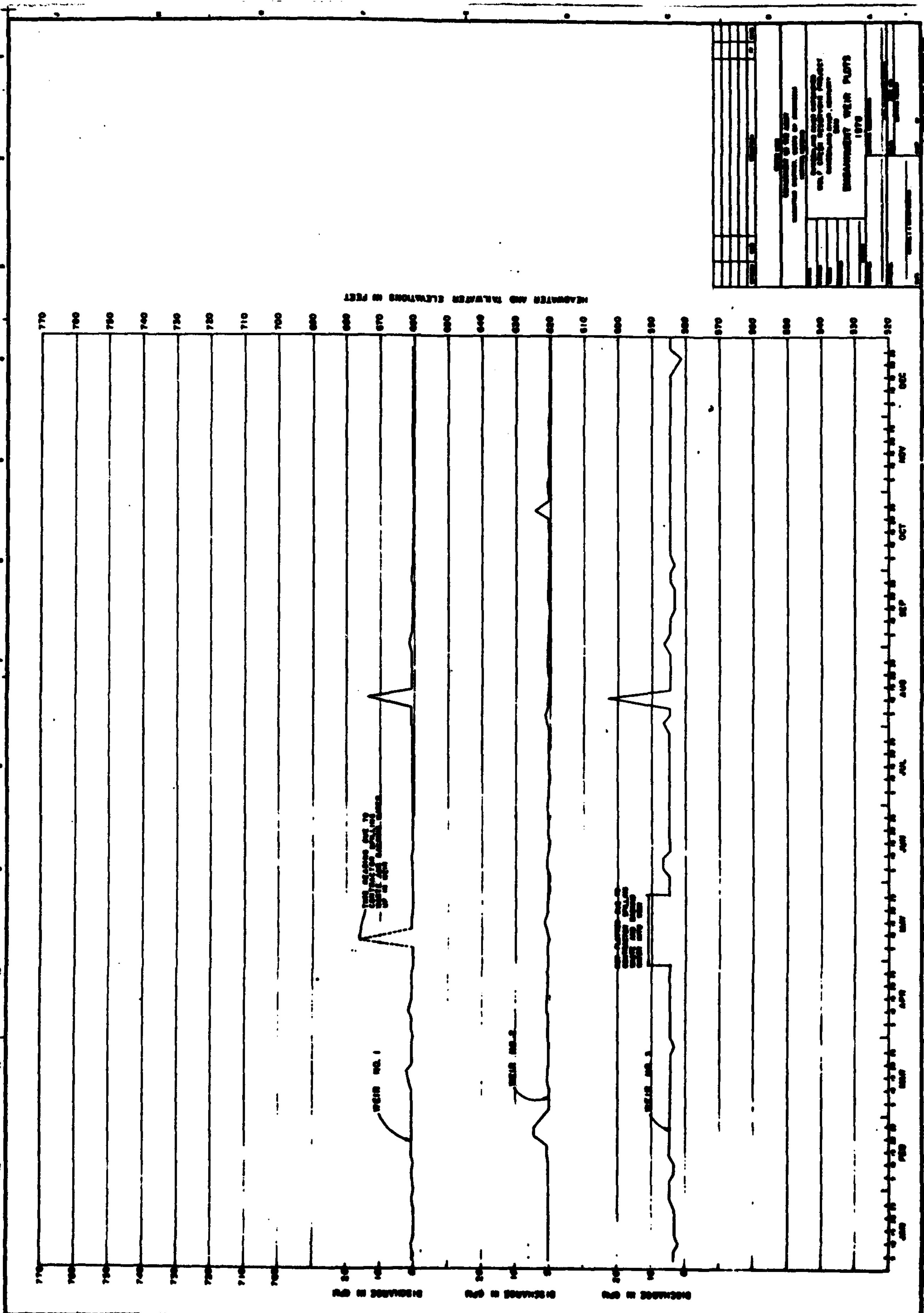

HEADWATER AND TAILWATER ELEVATIONS IN FEET
DISCHARGE IN GPM
WEIR NO 1
WEIR NO 2
WEIR NO 3
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
WOLF CREEK RESERVOIR PROJECT
EMBANKMENT WEIR PLOTS
1976

PLATE B- 34



EMBANKMENT WEIR PLOTS
1977



EMBANKMENT WEIR PLOTS
HEADWATER AND TAILWATER ELEVATIONS IN FEET
DISCHARGE IN GPM
WEIR NO. 1
WEIR NO. 2
WEIR NO. 3
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

PLATE B- 36

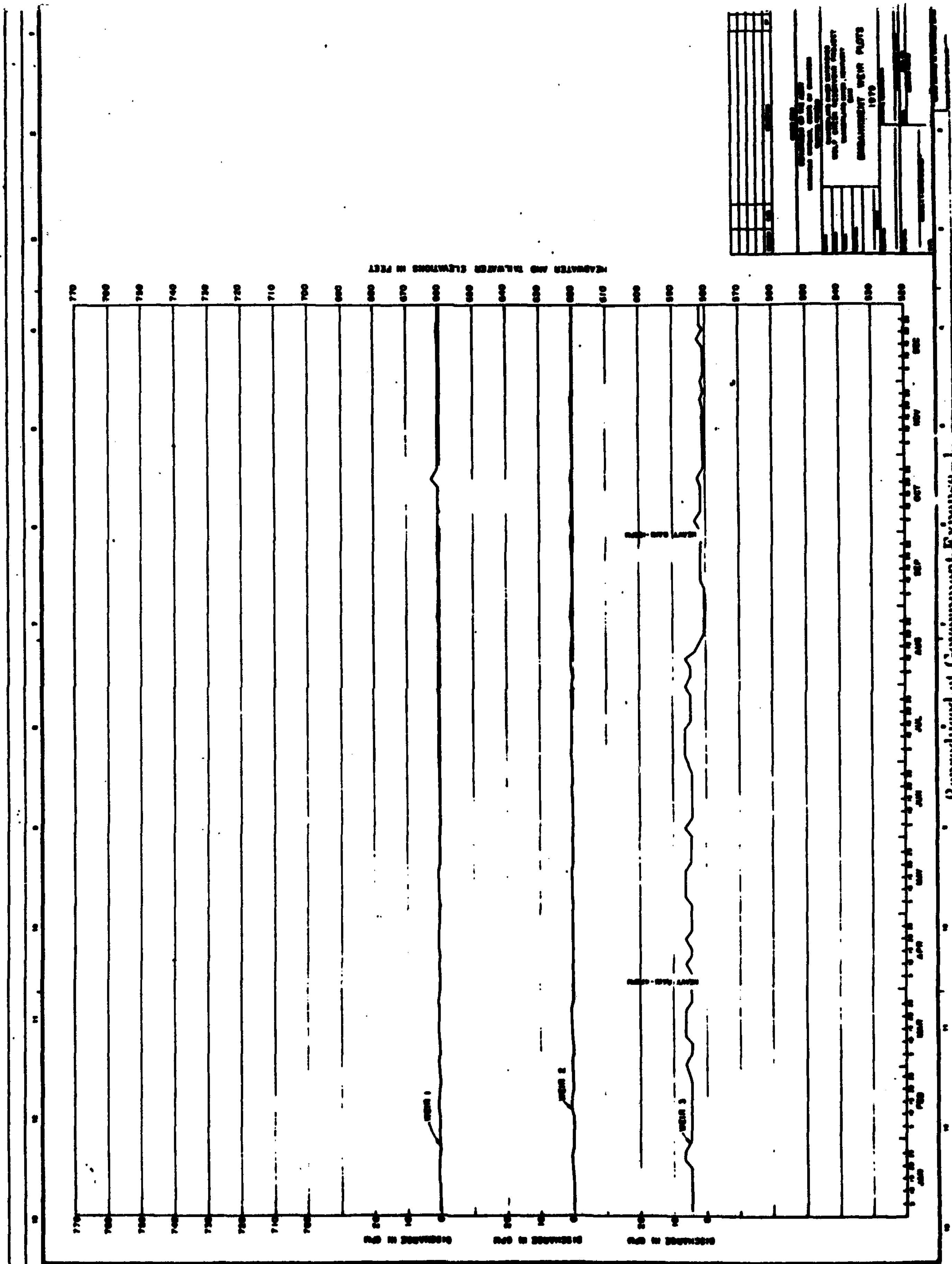


PLATE B- 37

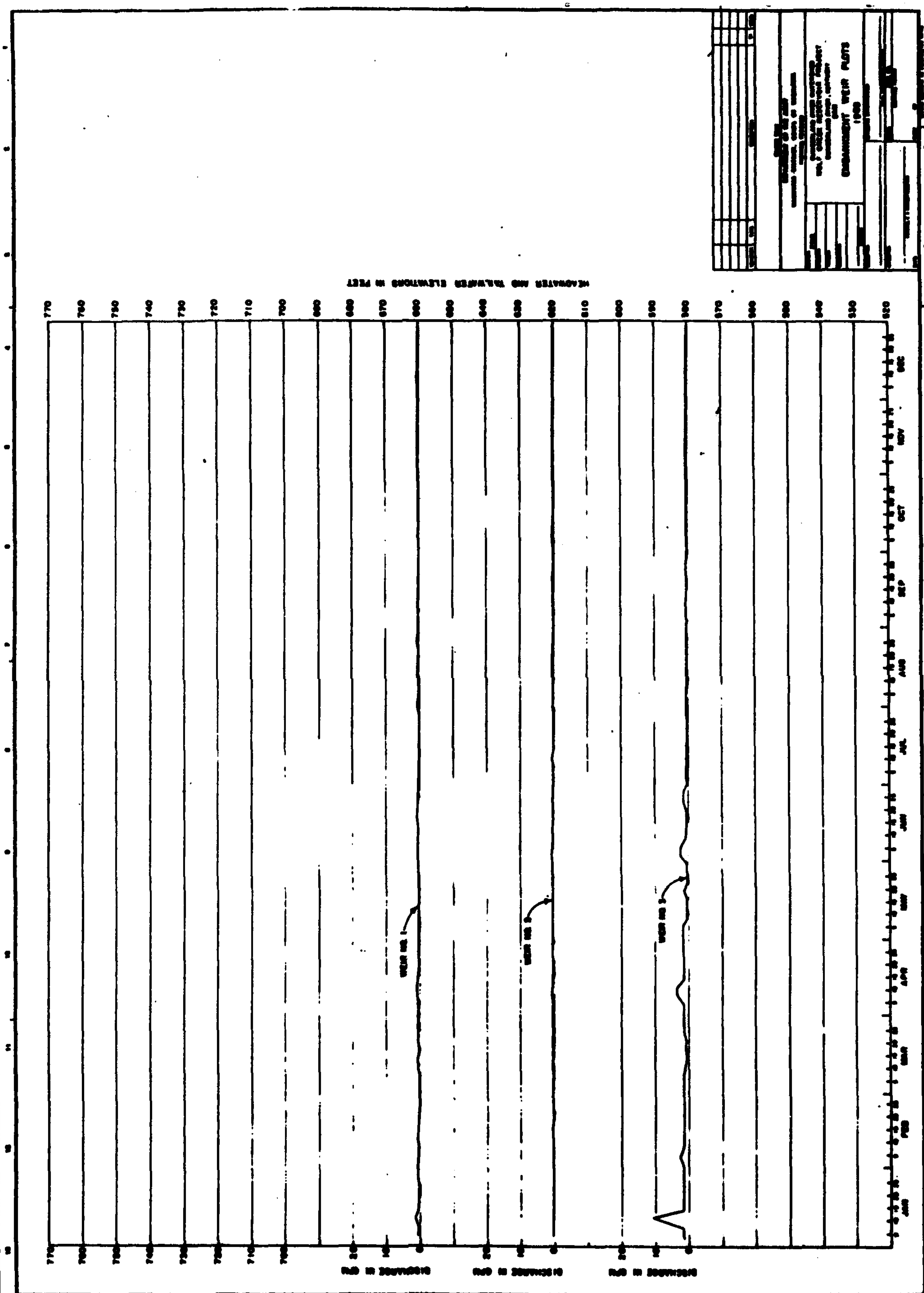
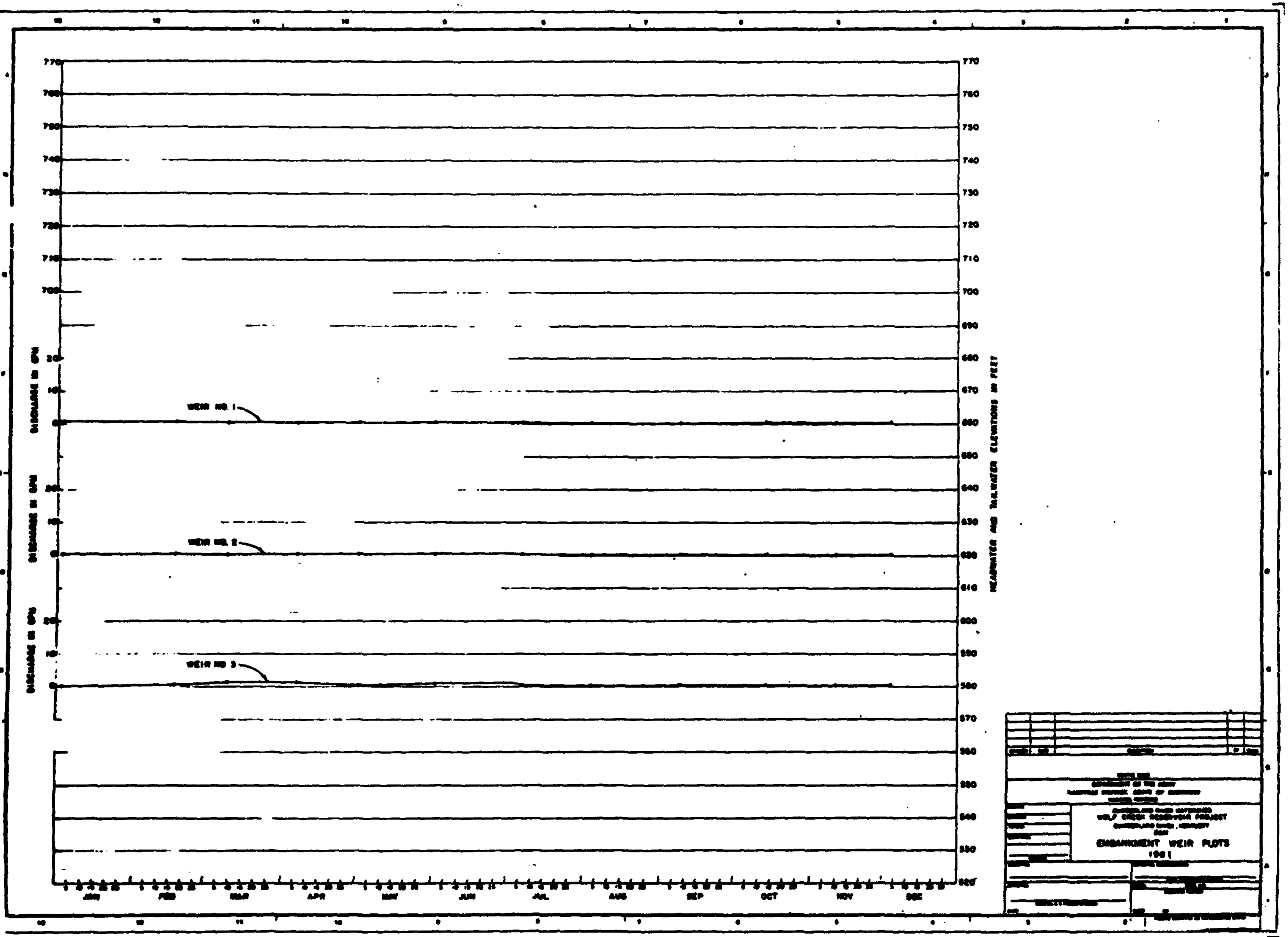

HEADWATER AND TAILWATER ELEVATIONS IN FEET
EMBANKMENT WEIR PLOTS
WEIR NO. 1
WEIR NO. 2
WEIR NO. 3
DISCHARGE IN GPM
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC

PLATE B- 38



HEADWATER AND TAILWATER ELEVATIONS IN FEET
770
760
750
740
730
720
710
700
690
680
670
660
650
640
630
620
610
600
590
580
570
560
550
540
530
520
DISCHARGE IN GPM
20
10
0
WEIR NO. 1
WEIR NO. 2
WEIR NO. 3
JAN
FEB
MAR
APR
MAY
JUN
JUL
AUG
SEP
OCT
NOV
DEC
WOLF CREEK RESERVOIR PROJECT
EMBANKMENT WEIR PLOTS

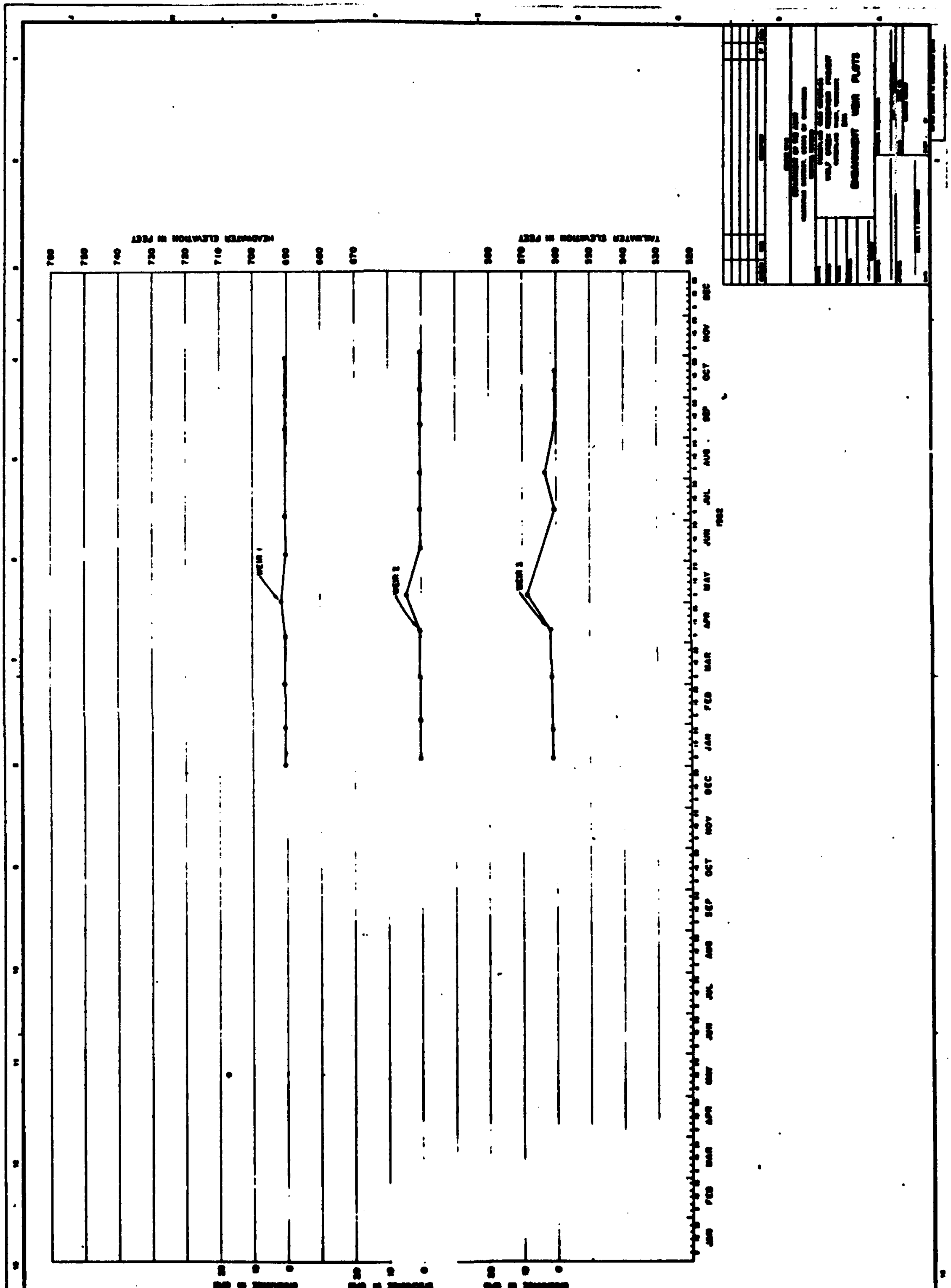
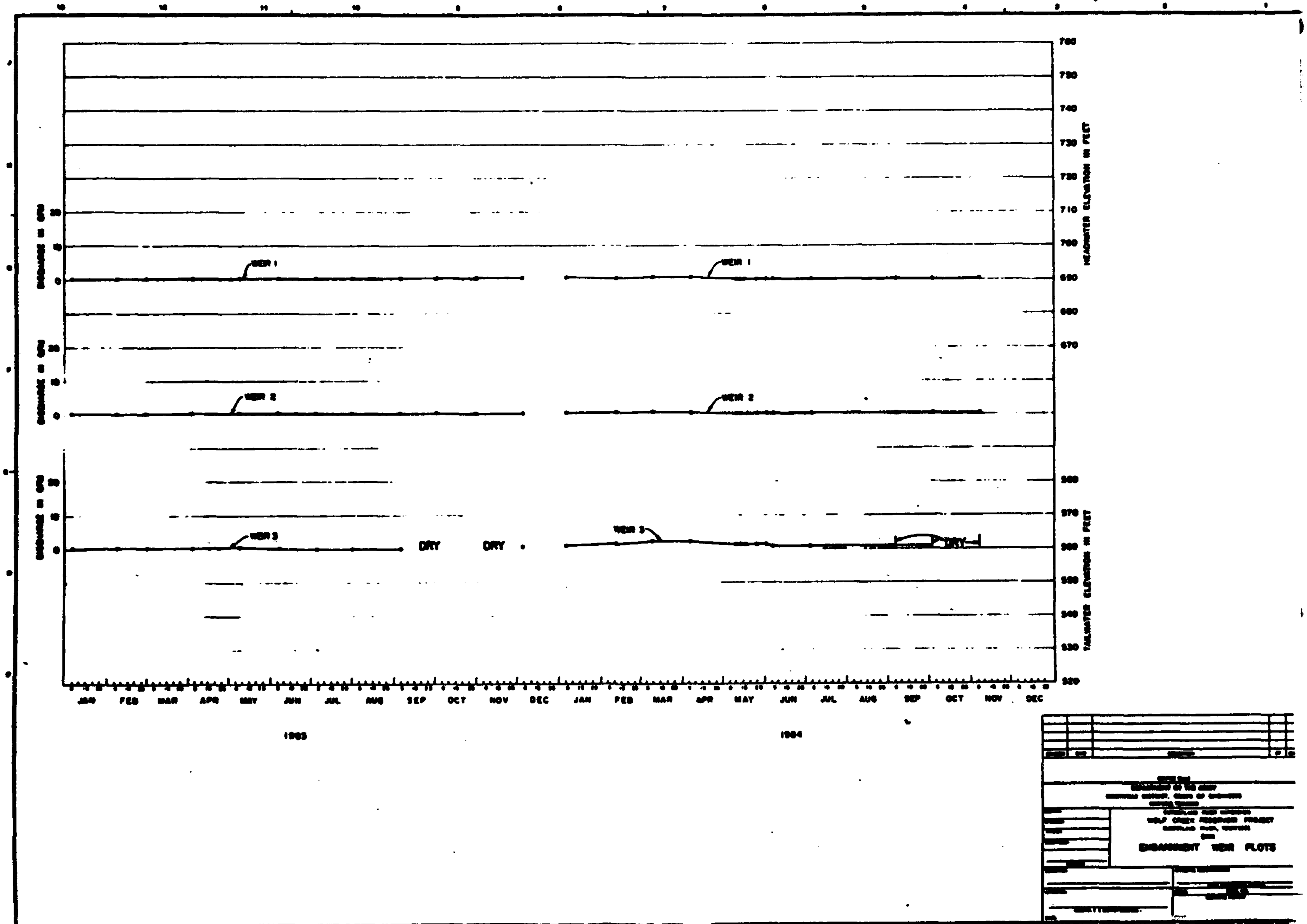
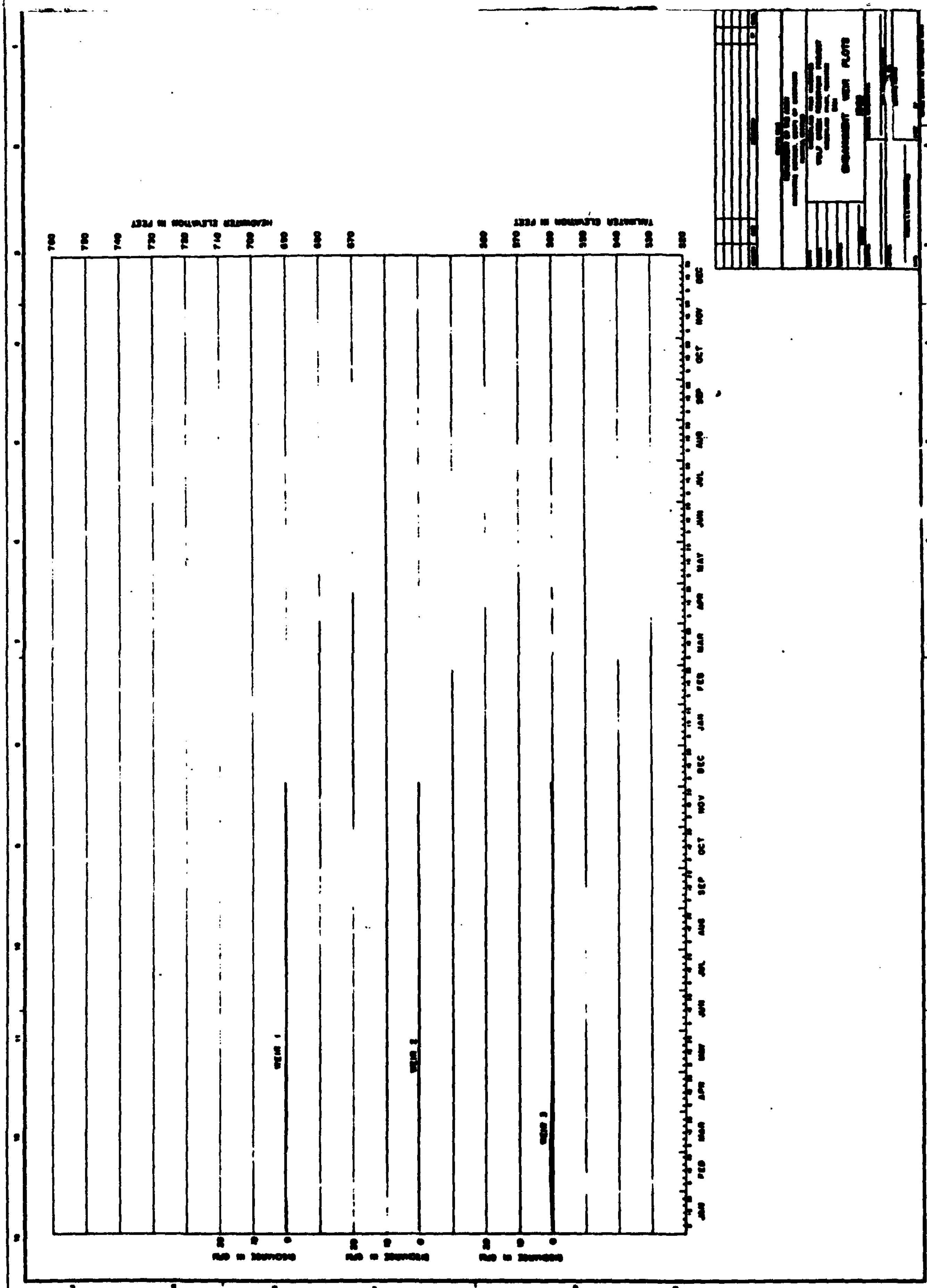

HEADWATER ELEVATION IN FEET
TAILWATER ELEVATION IN FEET
DISCHARGE IN CFS
WEIR 1
WEIR 2
WEIR 3
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
EMBANKMENT WEIR PLOTS

PLATE B- 40



HEADWATER ELEVATION IN FEET
TAILWATER ELEVATION IN FEET
DISCHARGE IN GPM
WEIR 1
WEIR 2
WEIR 3
DRY
JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC
1983
1984
EMBANKMENT WEIR PLOTS

PLATE B- 41

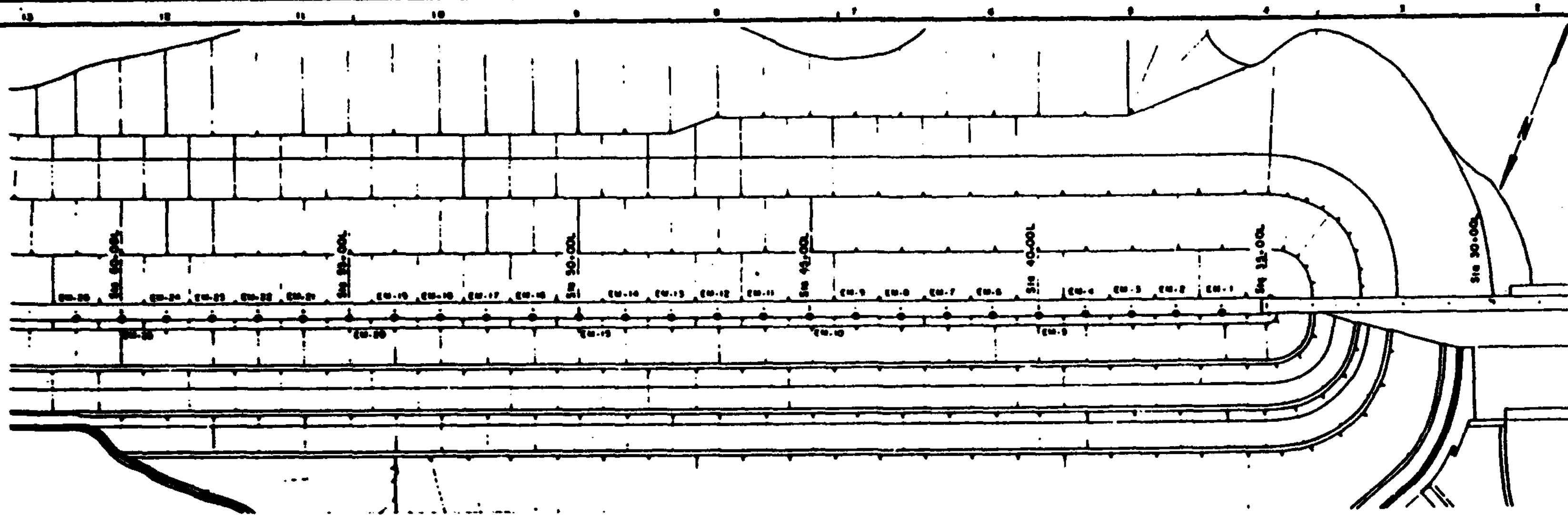


HEADWATER ELEVATION IN FEET
TAILWATER ELEVATION IN FEET
DISCHARGE IN CFS
WEIR 1
WEIR 2
WEIR 3

PLATE B- 42

EMBANKMENT MONUMENTATION DATA

SETTLEMENT AND LATERAL MOVEMENT



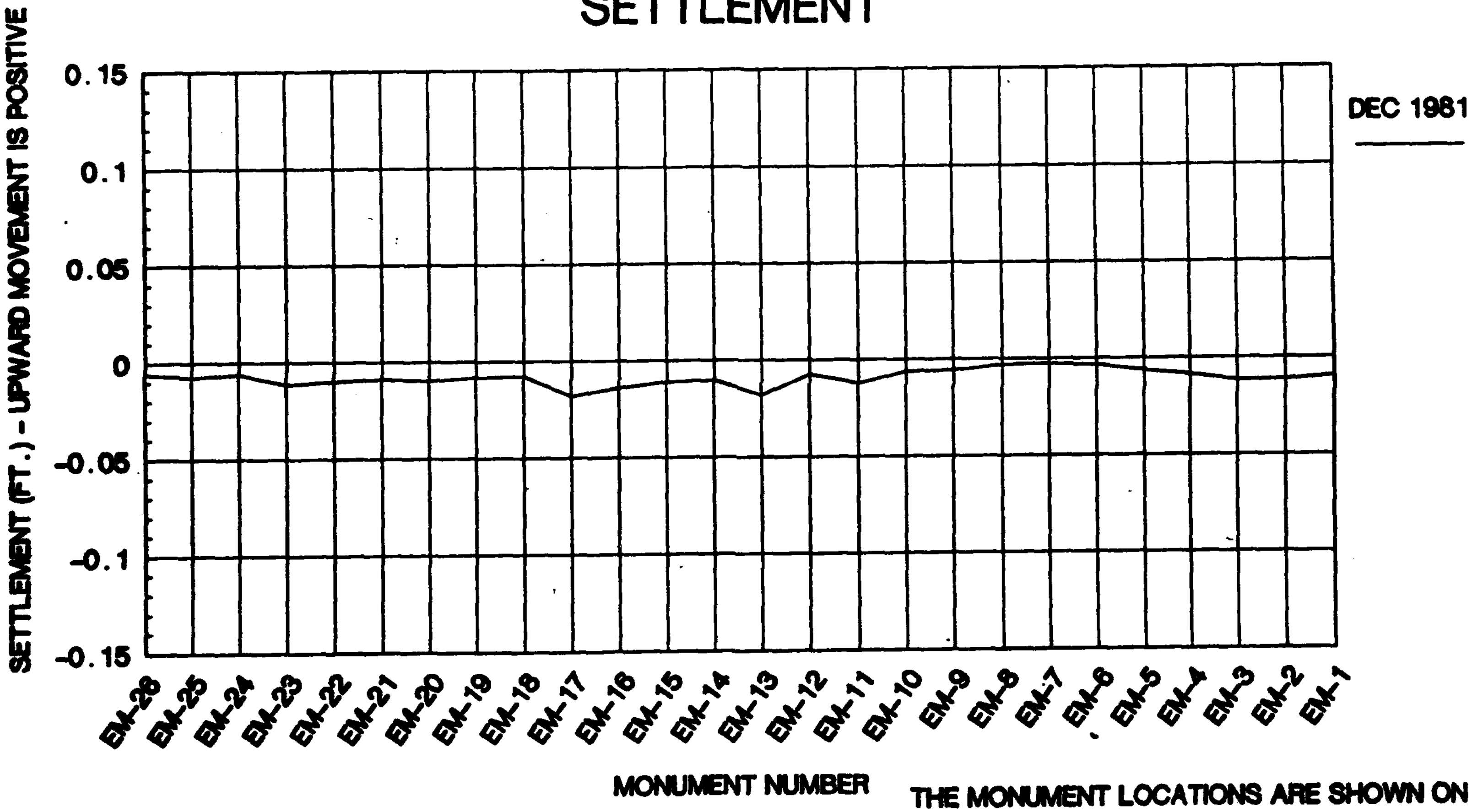
● EMBANKMENT MONUMENT

EMBANKMENT MONUMENTATION PLAN

WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER WATERSHED
CUMBERLAND RIVER, KENTUCKY
SETTLEMENT AND DISPLACEMENT

PLATE B- 43

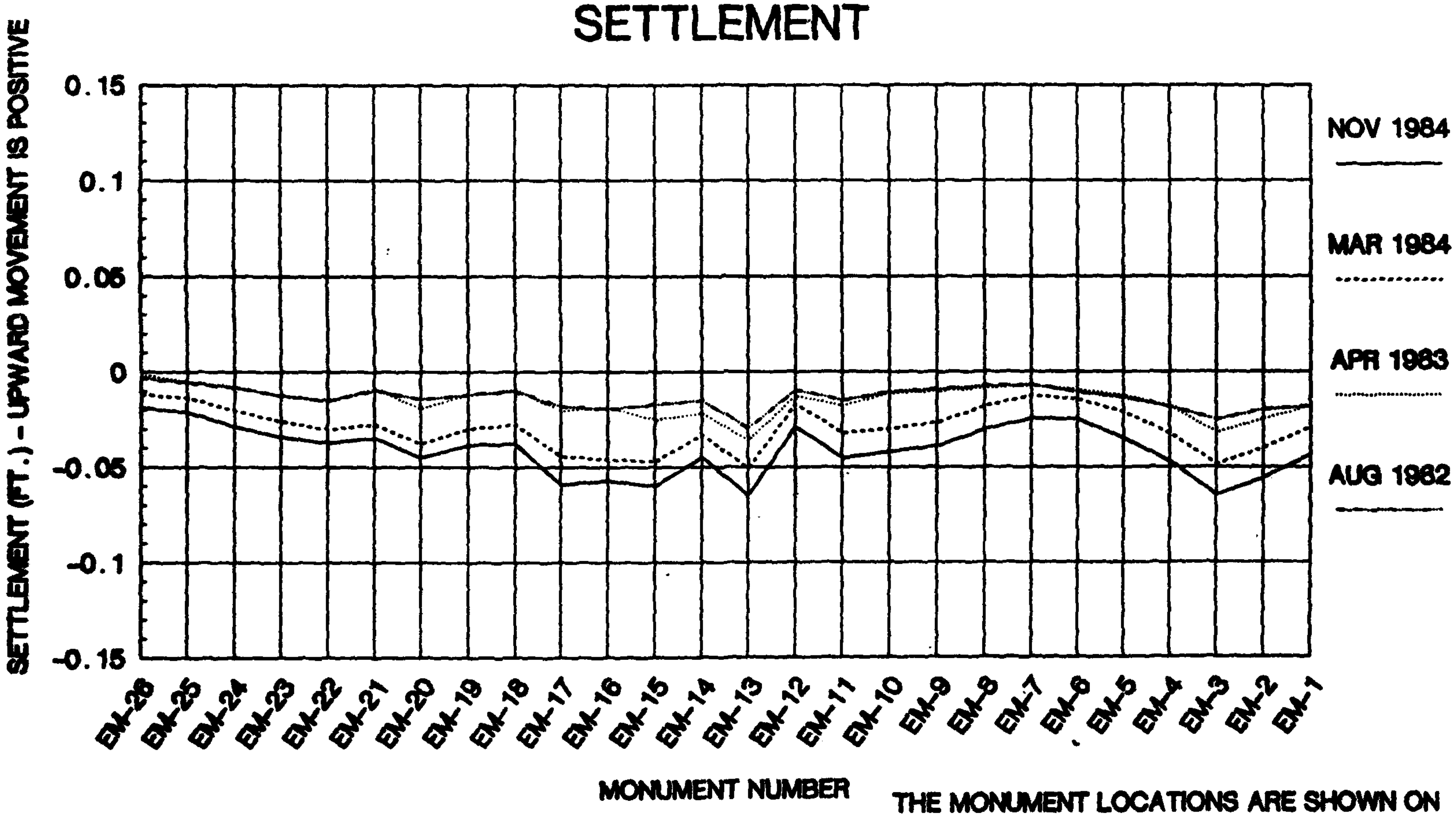
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

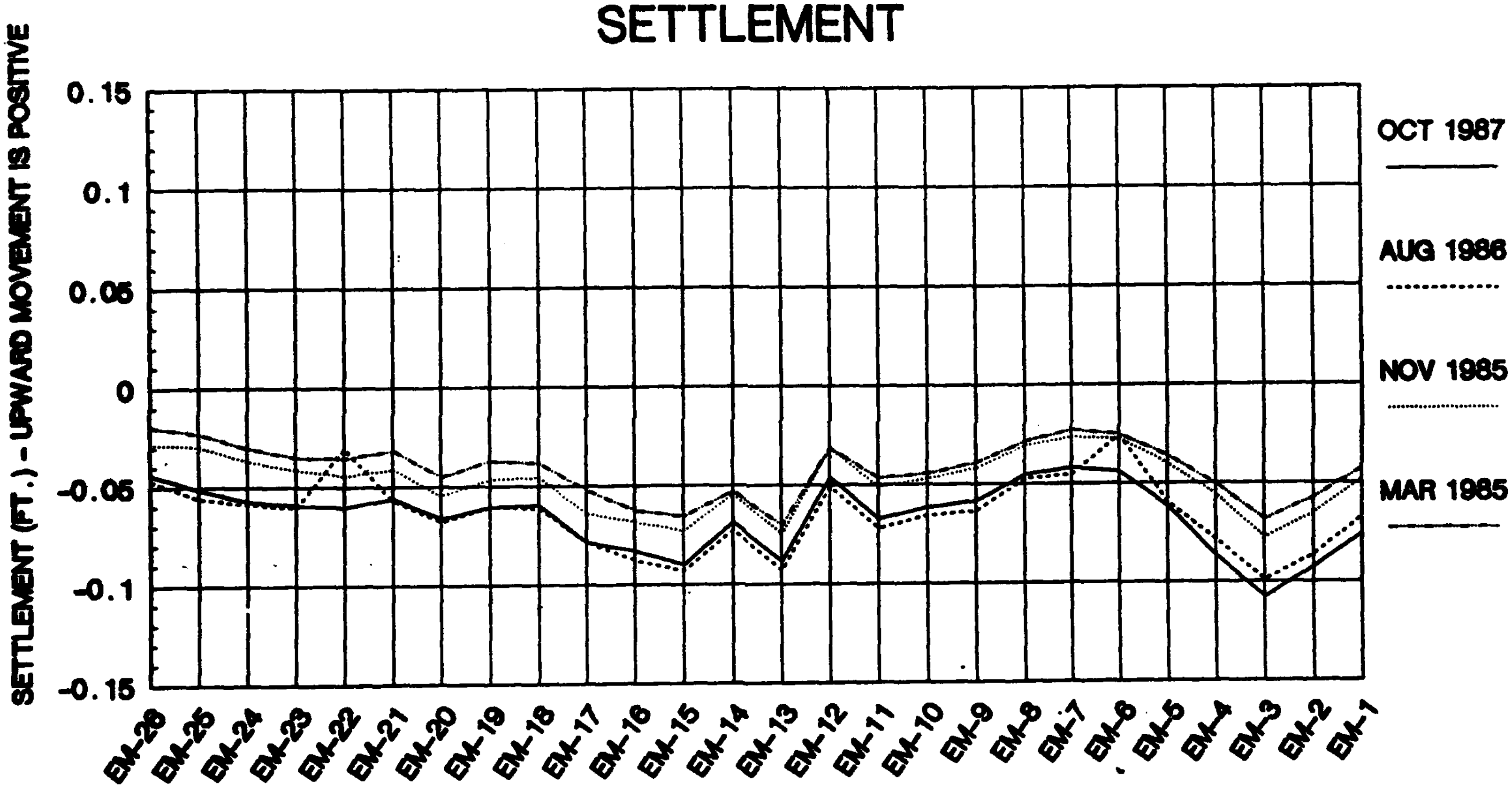
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

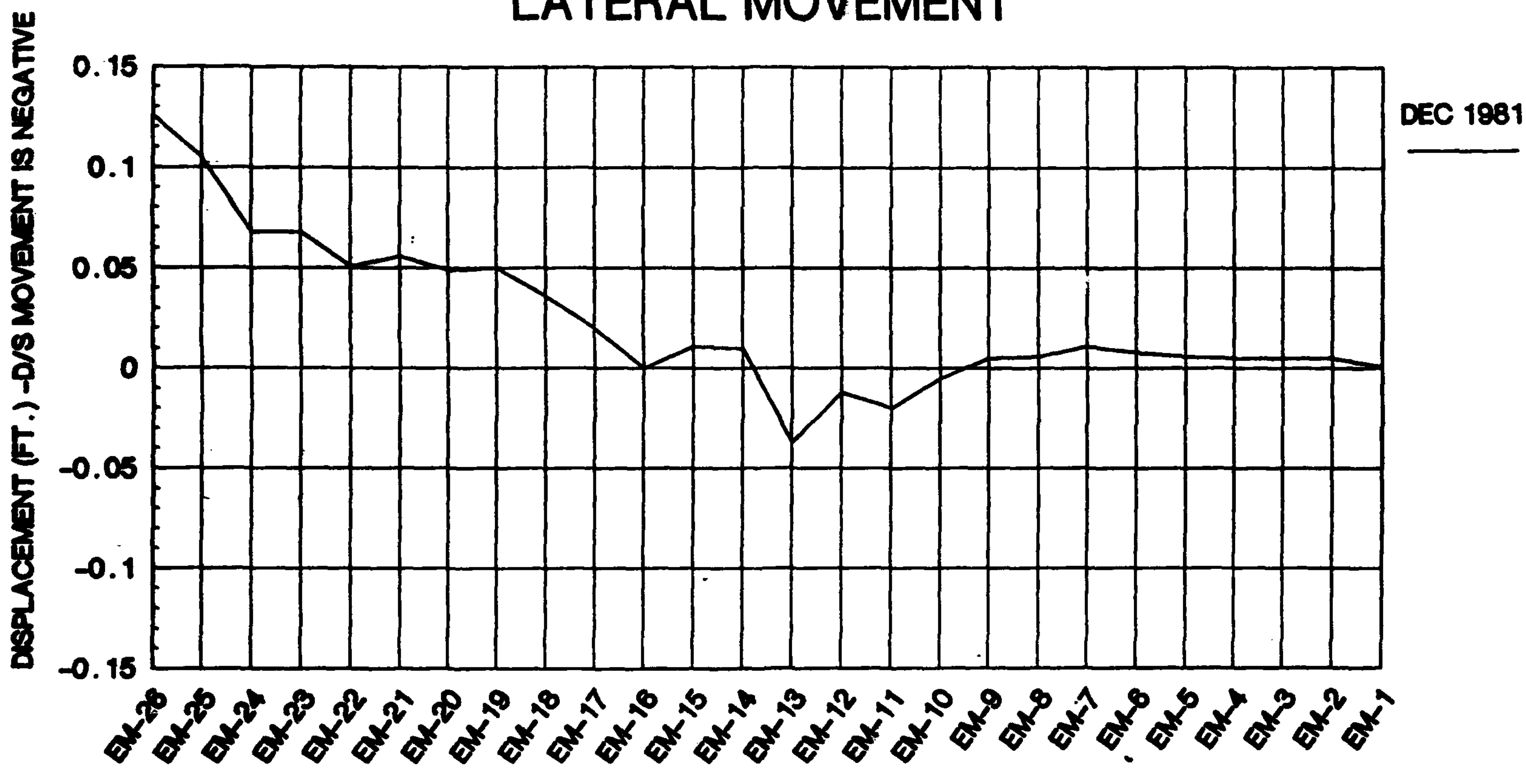
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

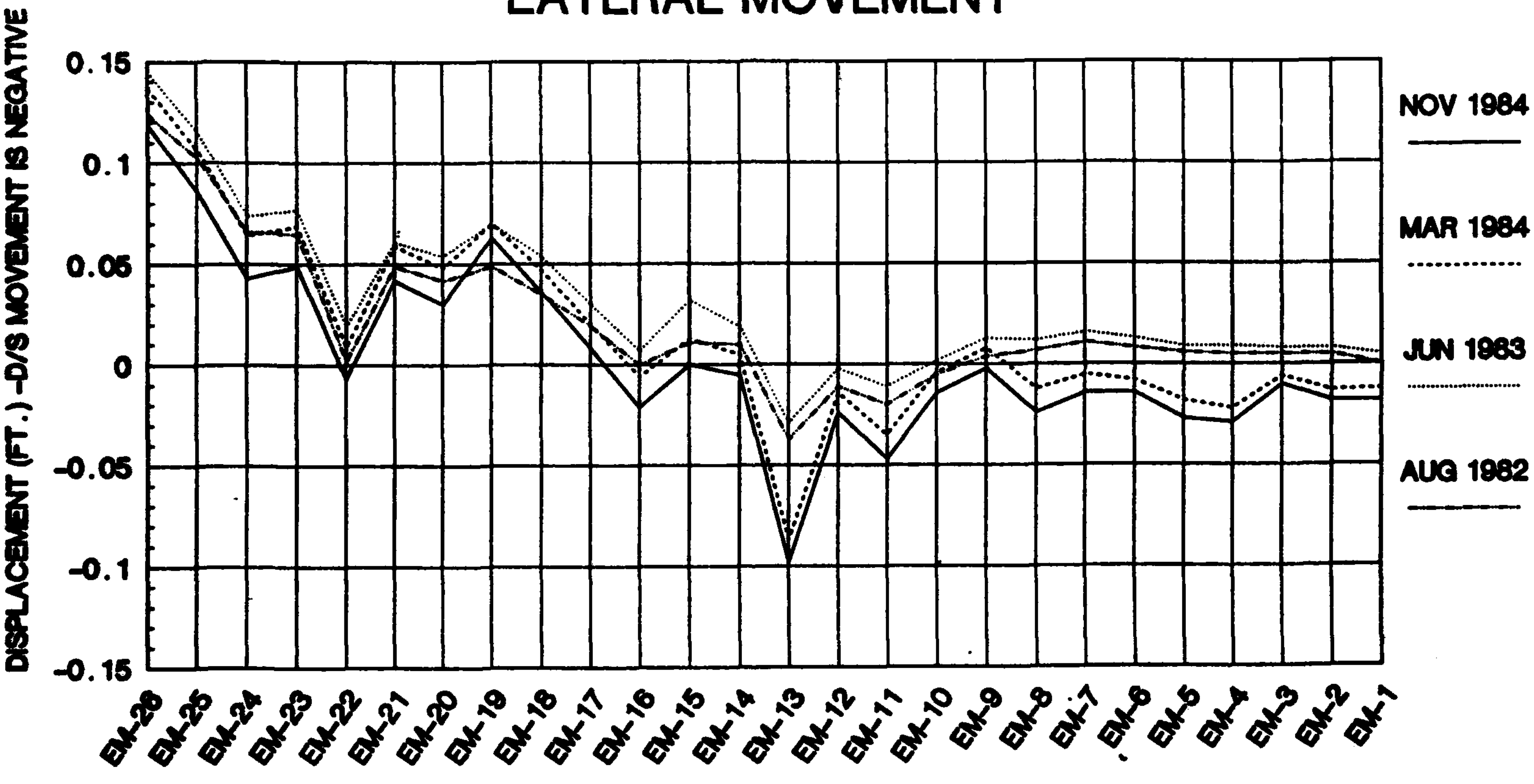
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
LATERAL MOVEMENT



THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 20 APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

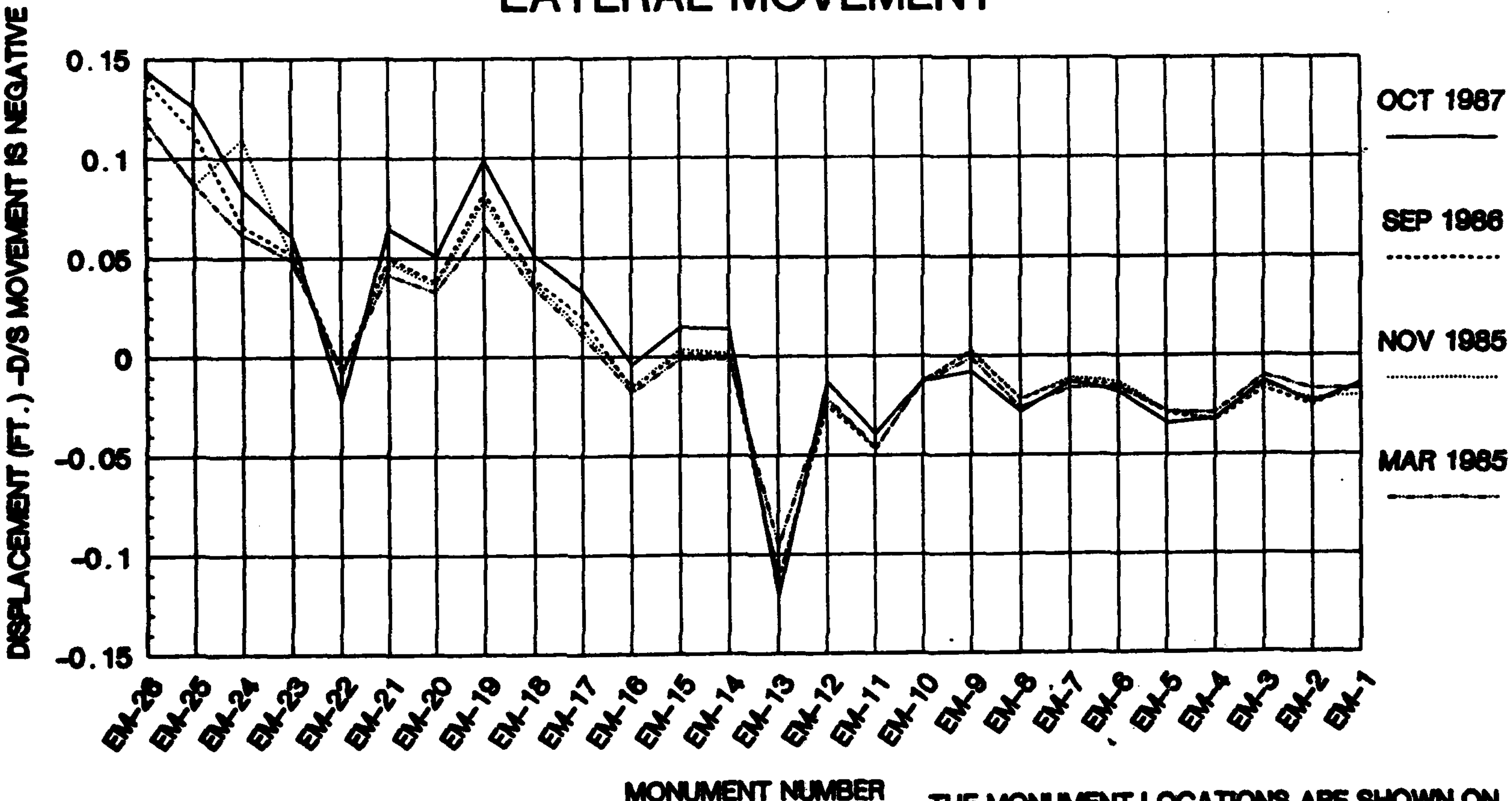
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
LATERAL MOVEMENT



THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 20 APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

WOLF CREEK DAM, JAMESTOWN, KENTUCKY
EMBANKMENT MONUMENTATION DATA
LATERAL MOVEMENT

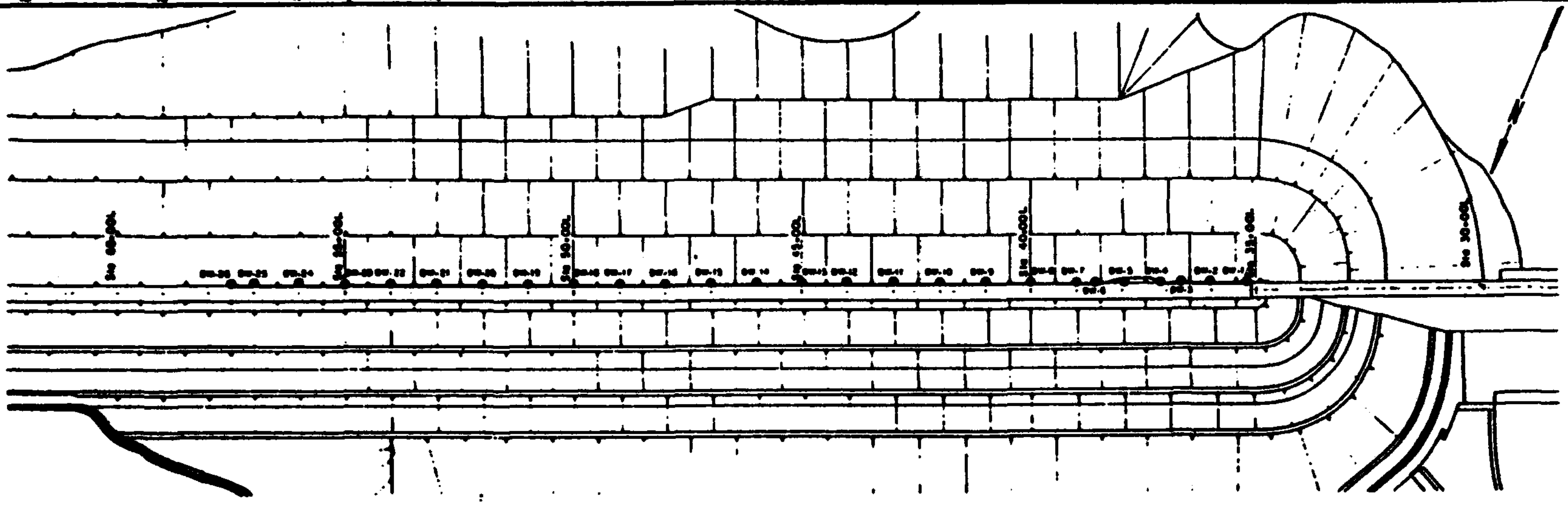


THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 20 APRIL 1981.

THE MONUMENT LOCATIONS ARE SHOWN ON EMBANKMENT MONUMENTATION PLAN (EM-1 IS NEAR CONC. DAM AND EM-26 NEAR RIGHT ABUTMENT)

DIAPHRAGM WALL MONUMENTATION DATA

SETTLEMENT AND LATERAL MOVEMENT



DIAPHRAGM WALL MONUMENTATION PLAN

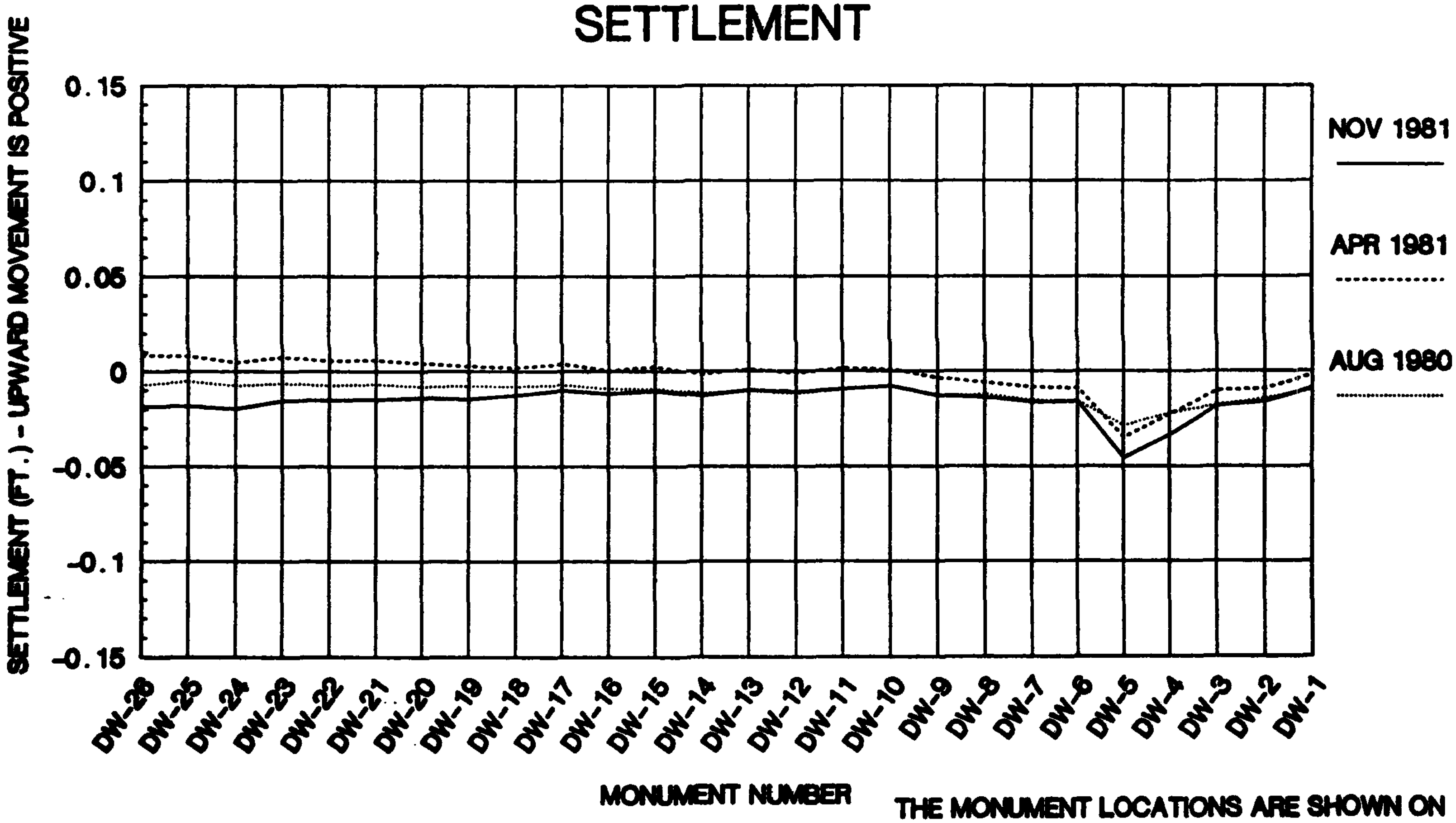
LEGEND
AUGUST
APRIL
DECEMBER

WOLF CREEK RESERVOIR PROJECT
CUMBERLAND RIVER WATERSHED
CUMBERLAND RIVER, KENTUCKY

SETTLEMENT AND DISPLACEMENT

PLATE B- 50

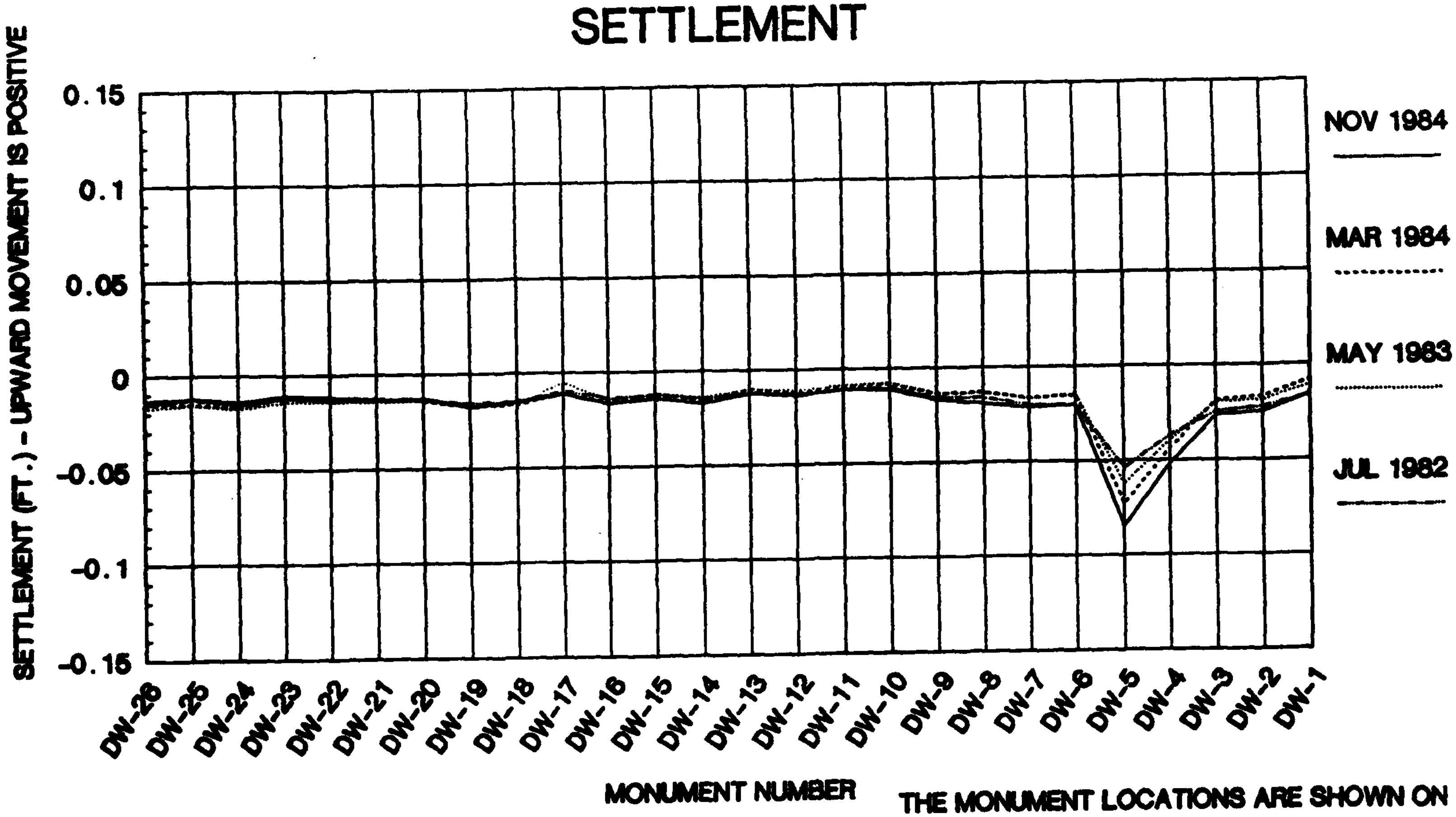
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF JUNE 1980.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

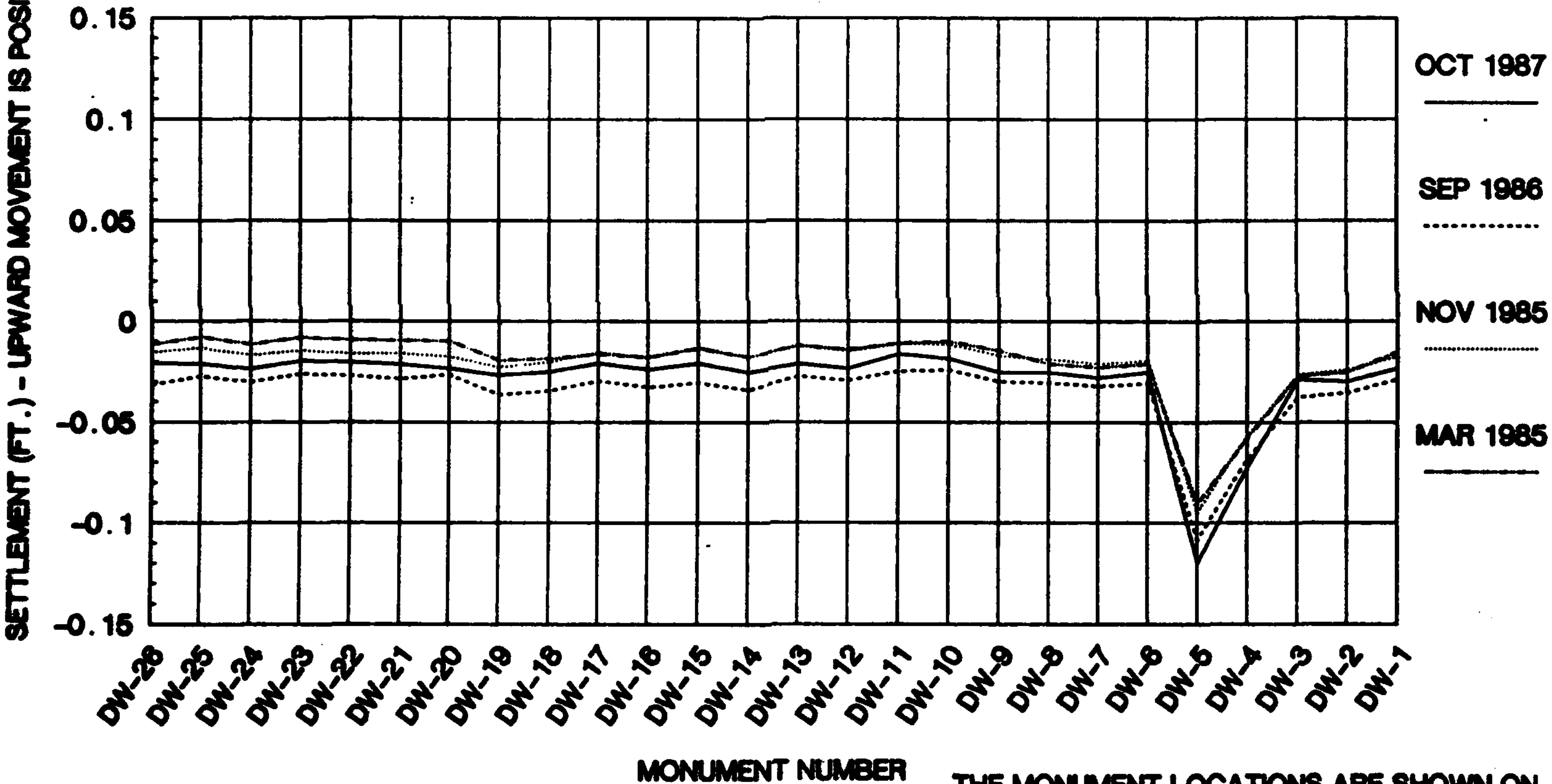
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF JUNE 1980.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

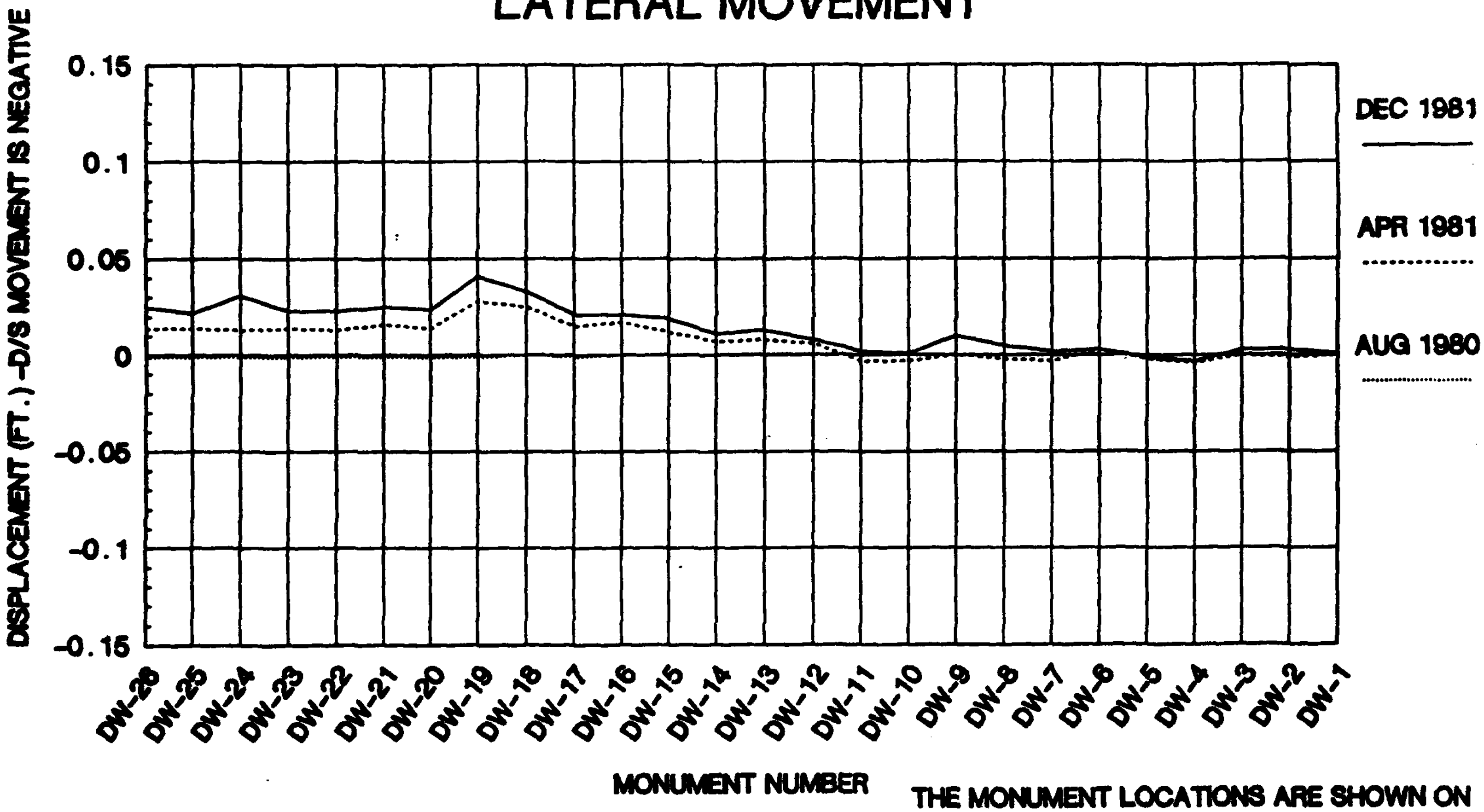
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
SETTLEMENT



THE SETTLEMENT IS CALCULATED FROM THE INITIAL READINGS OF JUNE 1960.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

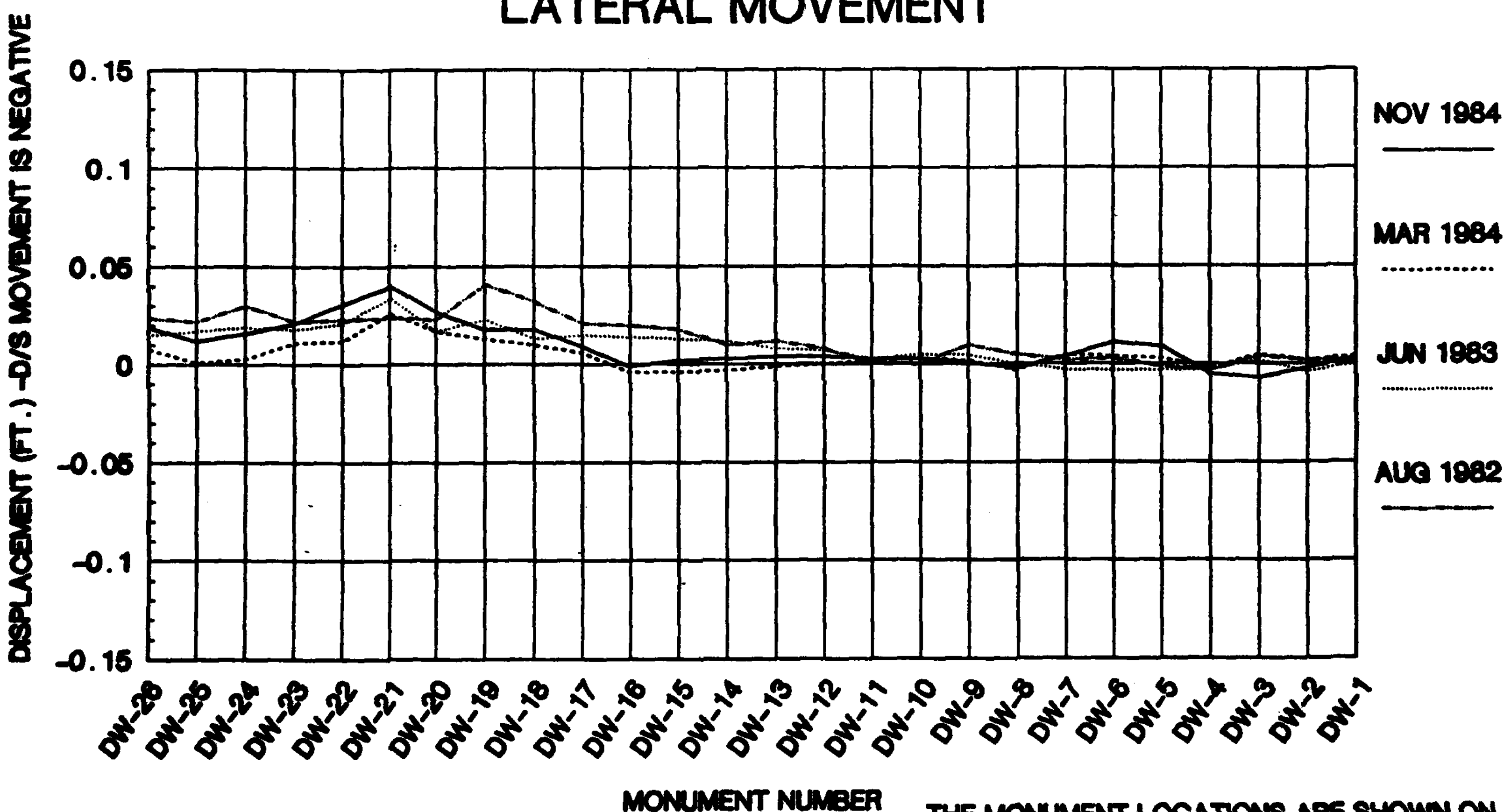
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
LATERAL MOVEMENT



THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 4 JUNE 1980.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

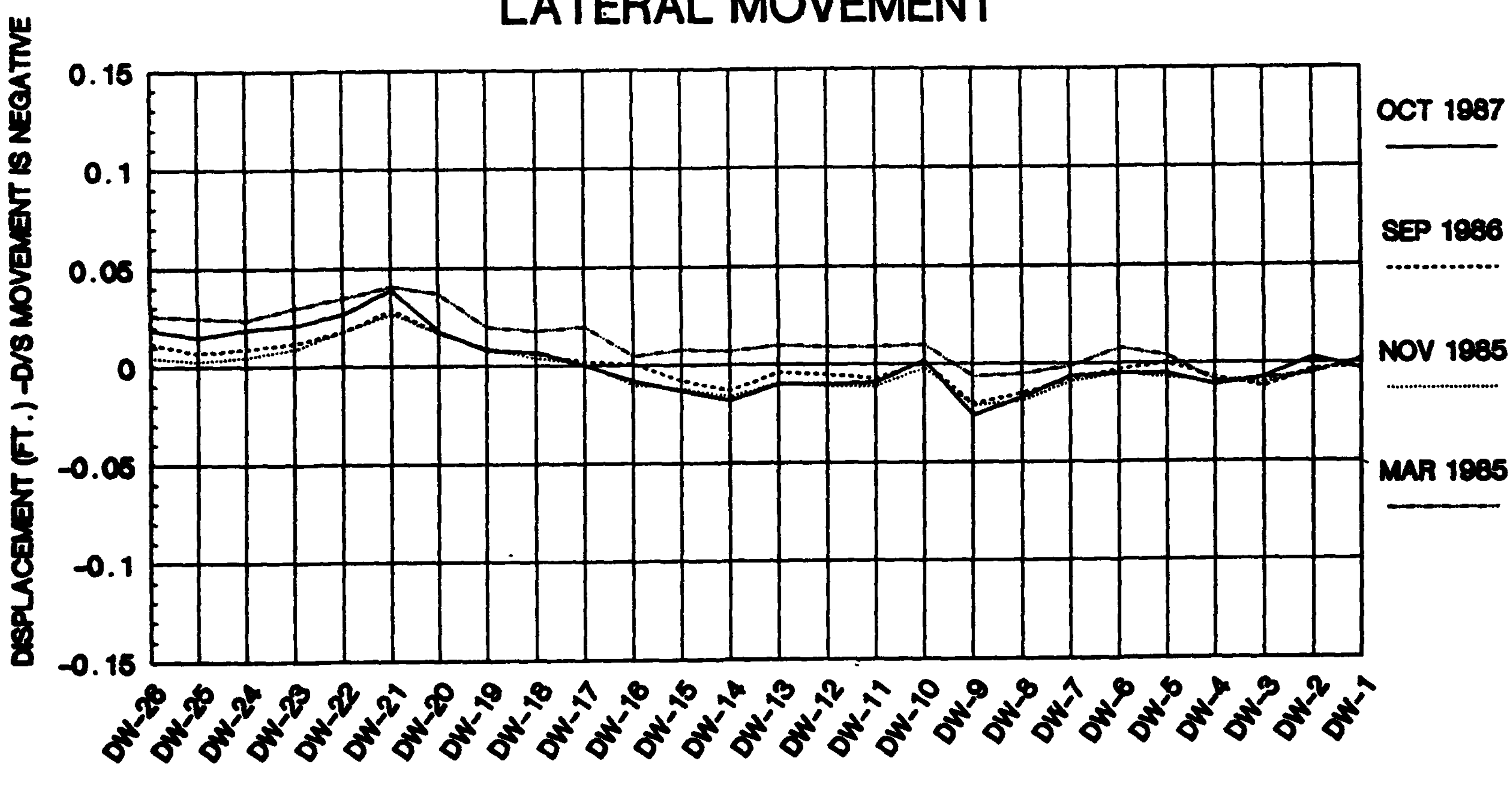
WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
LATERAL MOVEMENT



THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 4 JUNE 1980.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

WOLF CREEK DAM, JAMESTOWN, KENTUCKY
DIAPHRAGM WALL MONUMENTATION DATA
LATERAL MOVEMENT

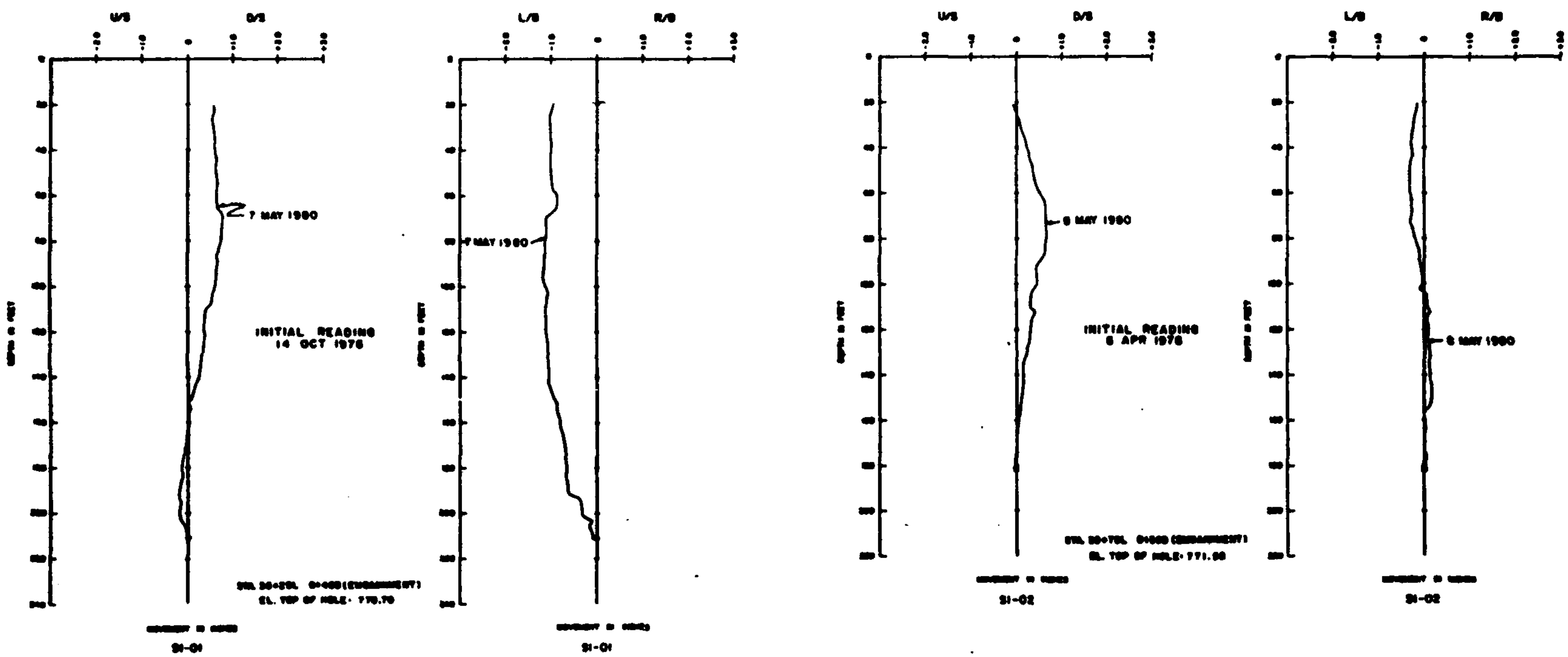


THE MOVEMENTS ARE CALCULATED FROM ORIGINAL READINGS OF 4 JUNE 1980.

THE MONUMENT LOCATIONS ARE SHOWN ON DIAPHRAGM WALL MONUMENTATION PLAN (DW-1 IS NEAR CONC. DAM AND DW-26 NEAR RIGHT ABUTMENT)

INCLINOMETER DATA

LATERAL MOVEMENT OF DIAPHRAGM WALL AND EMBANKMENT



NOTES:
1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION.
2. FOR LOCATION OF INCLINOMETERS, SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING.

INCLINOMETER
INTERNAL DISPLACEMENT

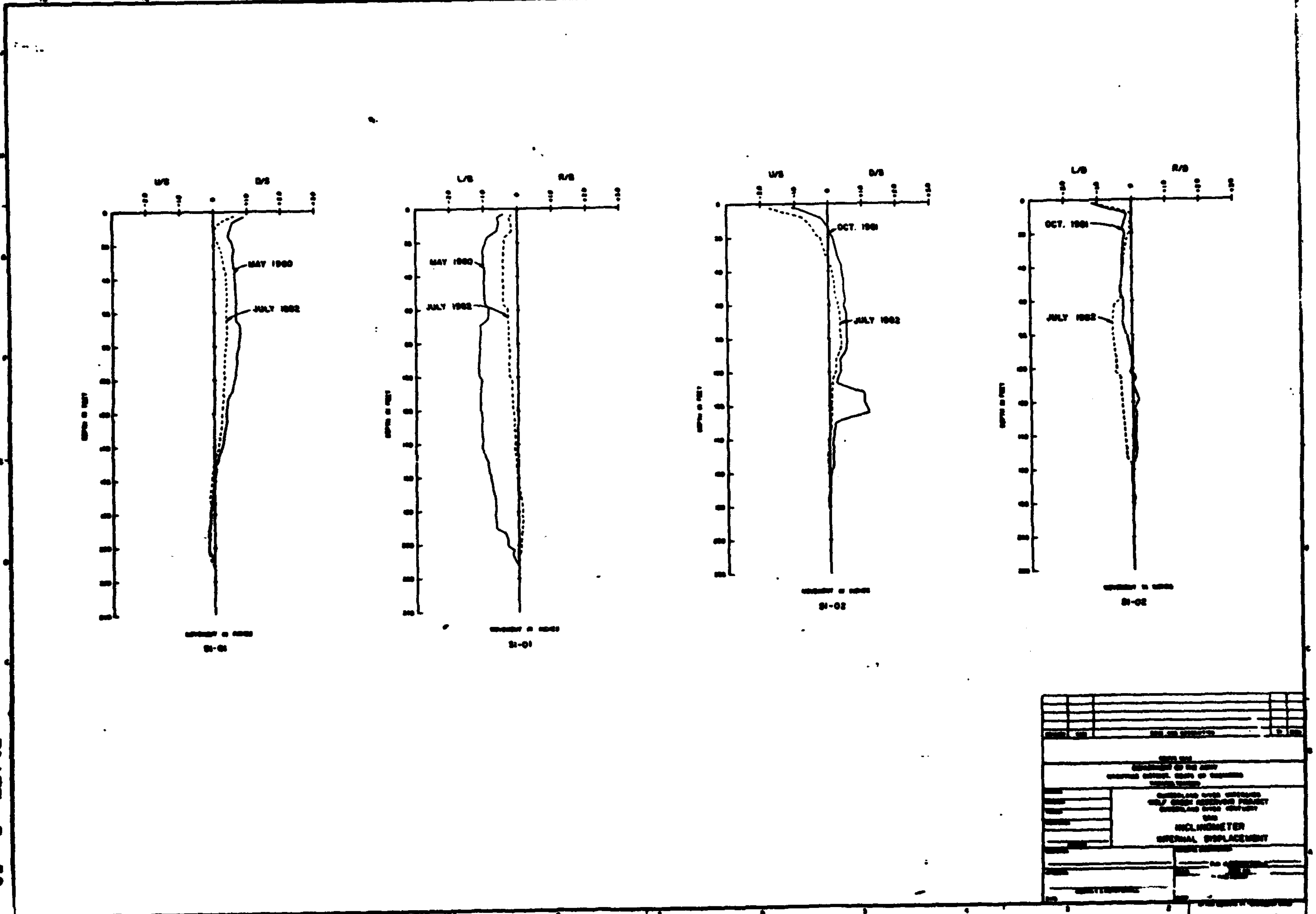

U/S
D/S
MAY 1980
JULY 1982
SI-01
L/S
R/S
MAY 1980
JULY 1982
SI-01
U/S
D/S
OCT. 1981
JULY 1982
SI-02
L/S
R/S
OCT. 1981
JULY 1982
SI-02
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 58

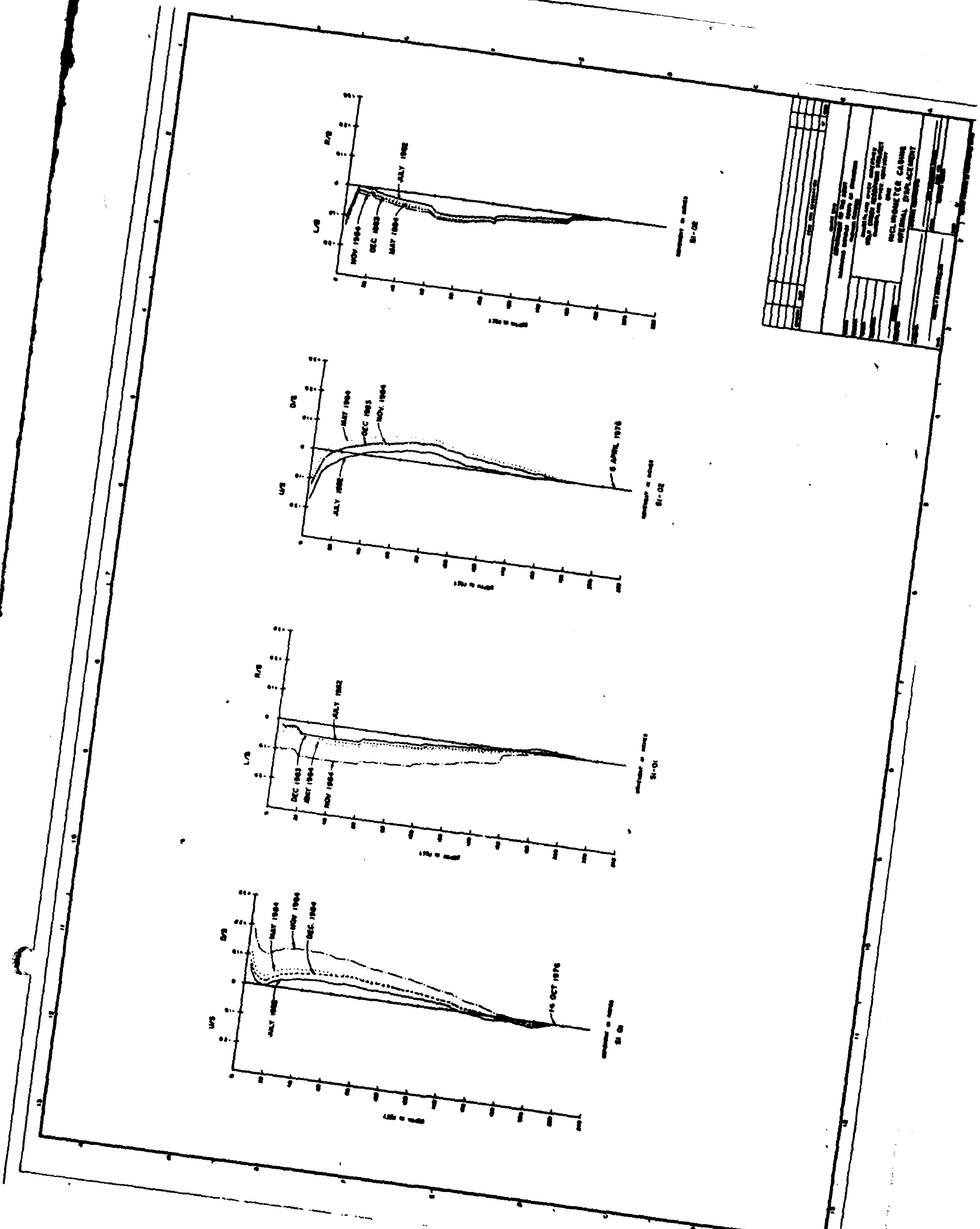
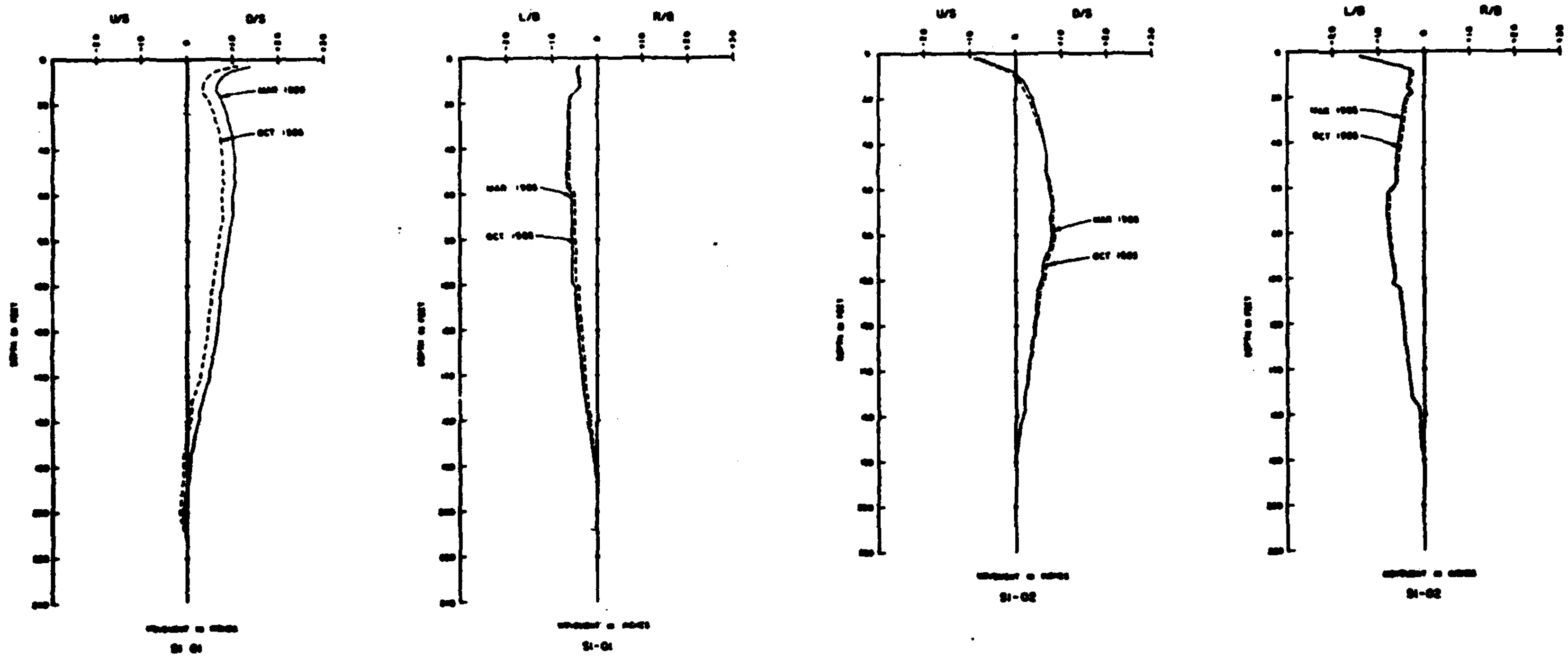

NOV 1984
DEC 1983
MAY 1984
JULY 1982
SI-02
MAY 1984
DEC 1983
NOV 1984
JULY 1982
6 APRIL 1976
SI-02
JULY 1982
DEC 1983
MAY 1984
NOV 1984
SI-01
MAY 1984
NOV 1984
DEC 1984
JULY 1982
14 OCT 1976

PLATE B- 59



INCLINOMETER

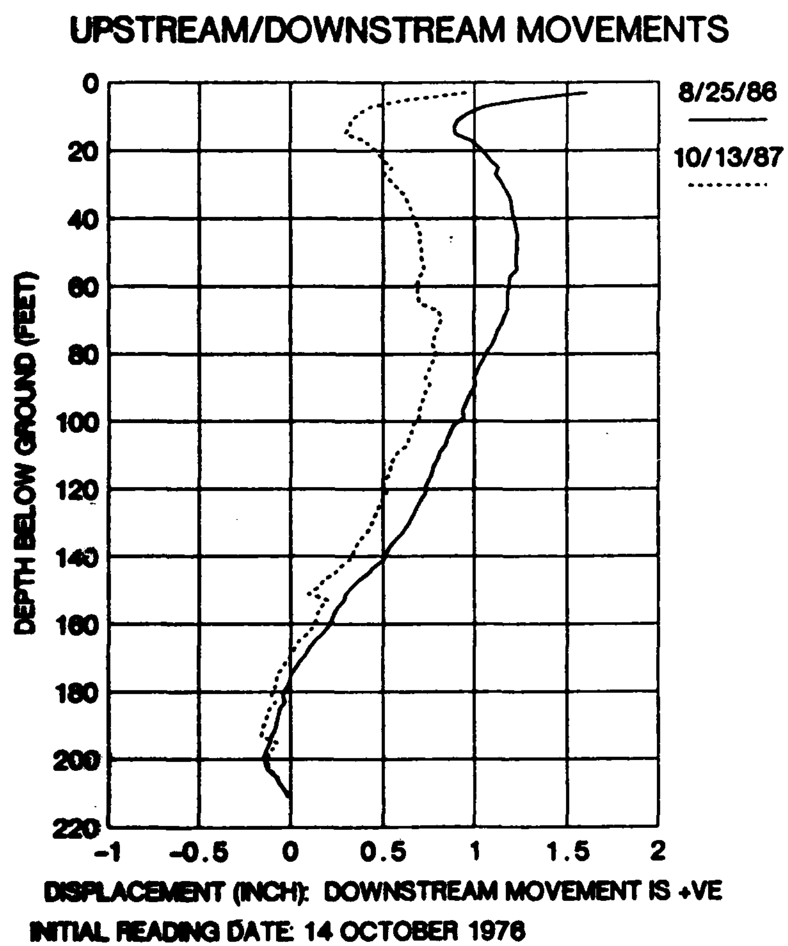
INTERNAL DISPLACEMENT

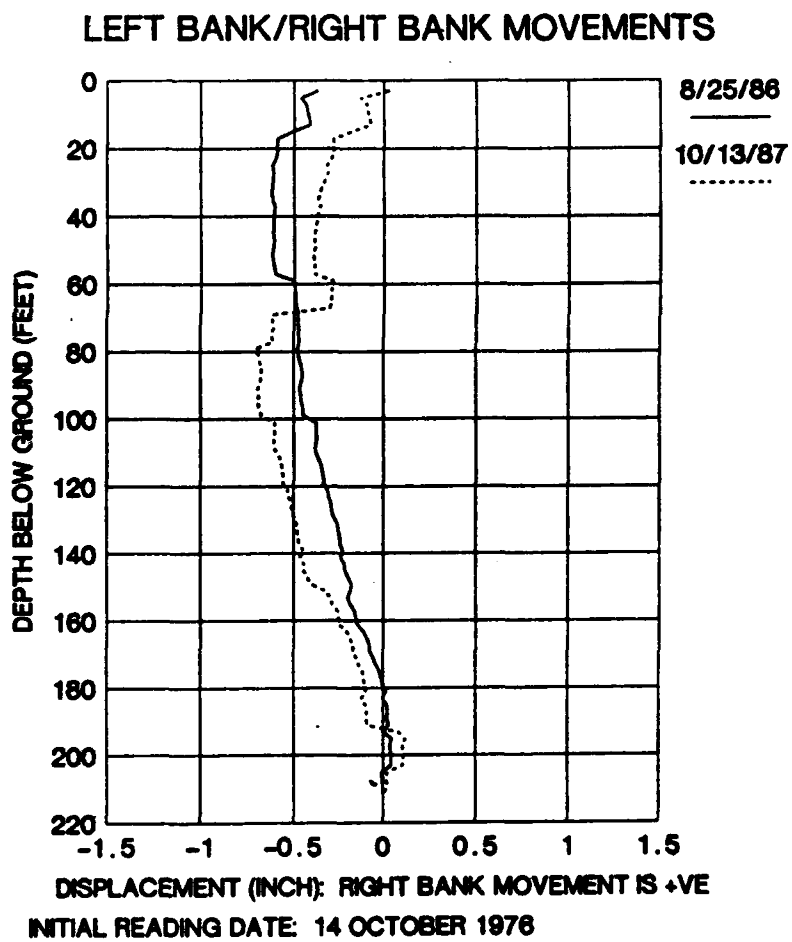
PLATE B- 60

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-01

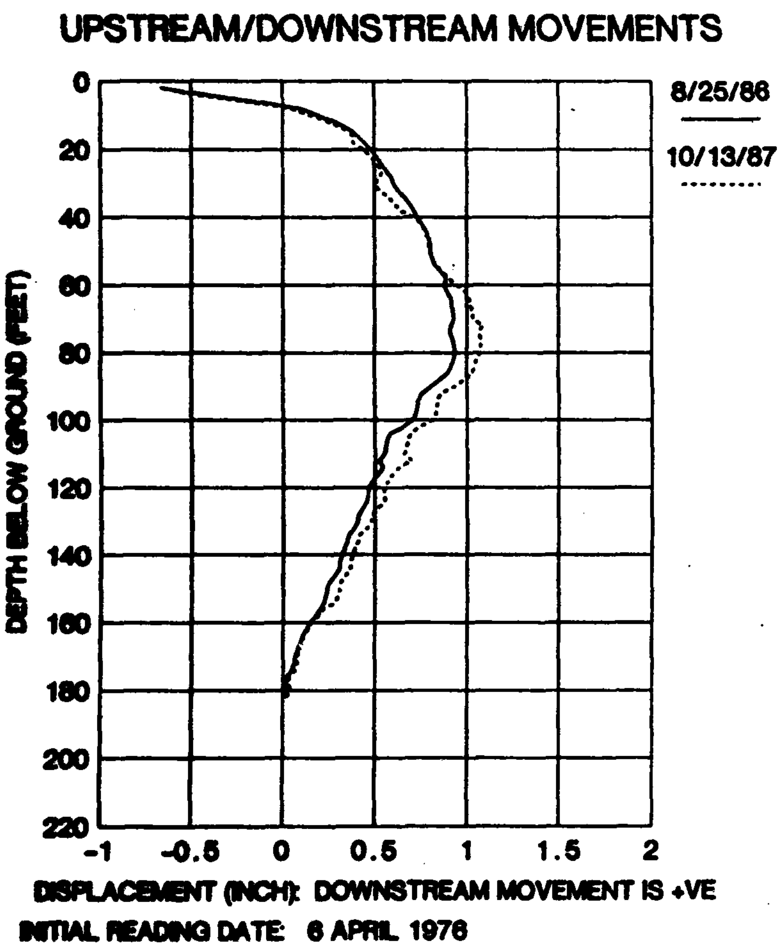


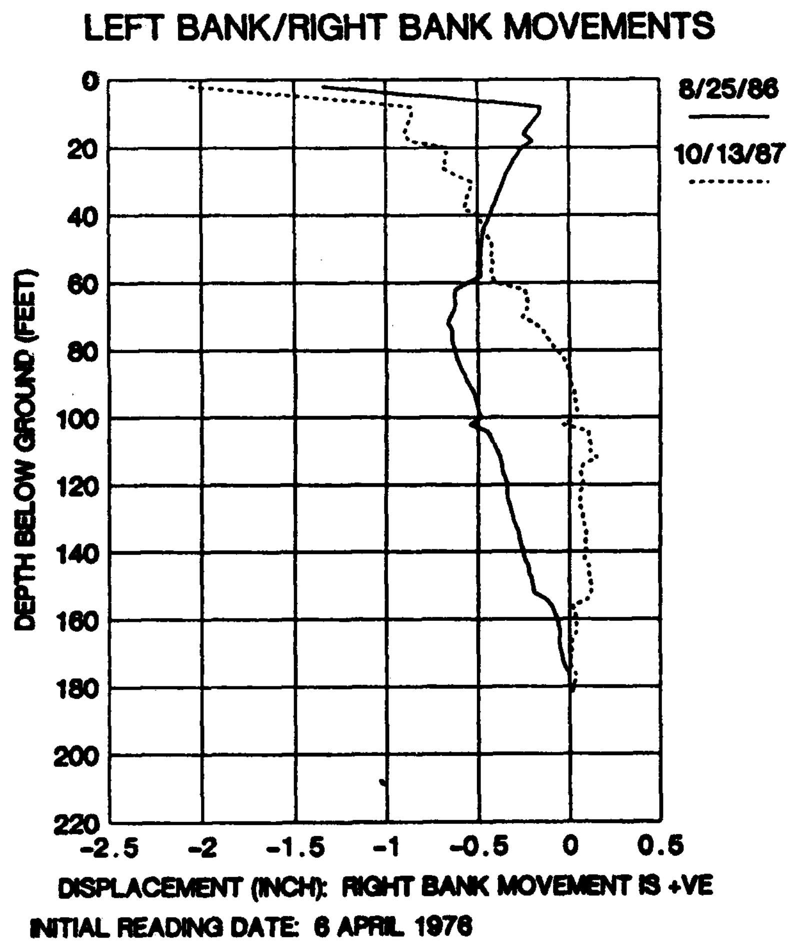


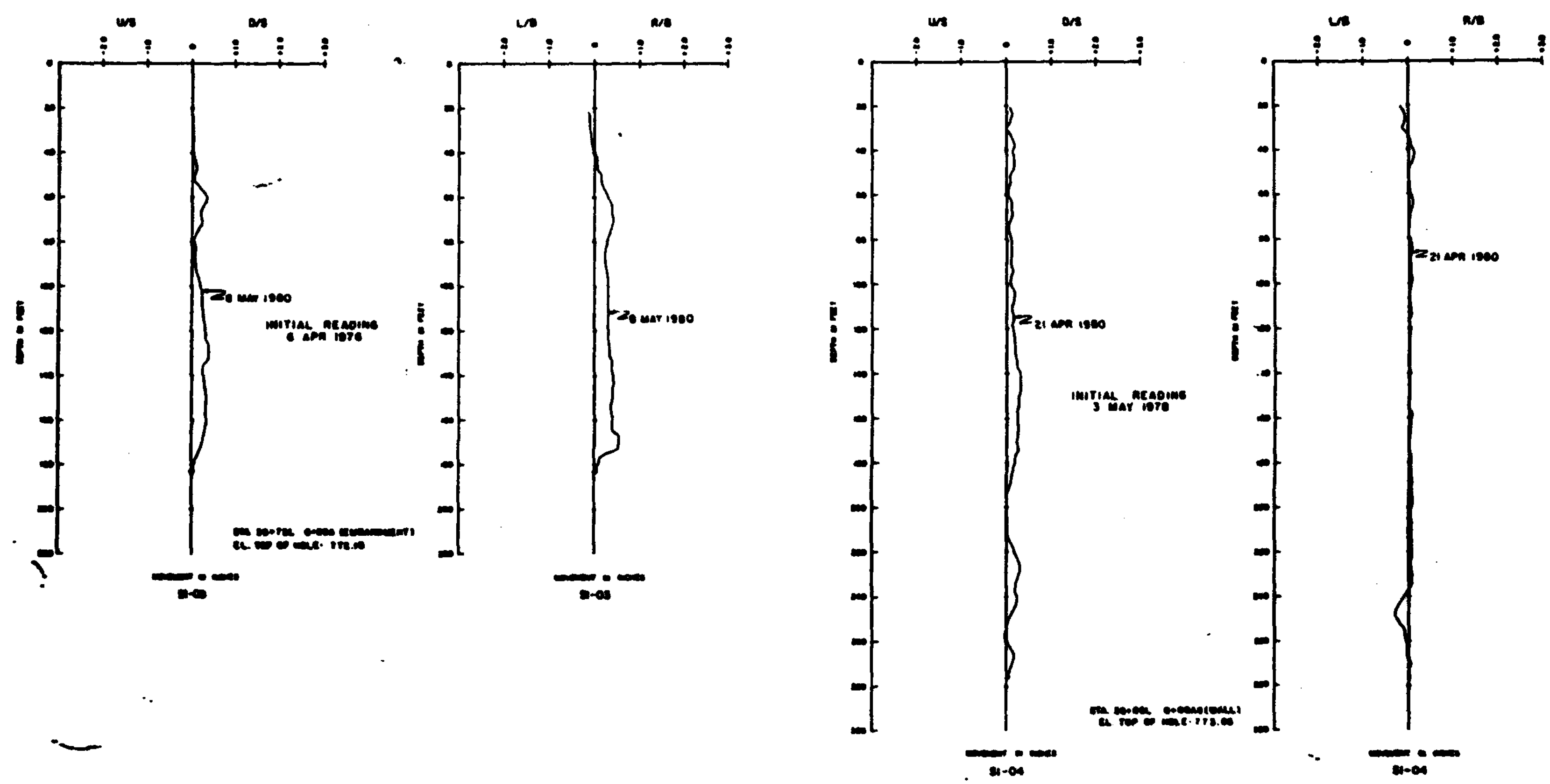
WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-02







NOTES:

1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION.
2. FOR LOCATION OF INCLINOMETERS SEE PIEZOMETERS AND INCLINOMETERS LOCATION DRAWING.

DEPARTMENT OF THE ARMY

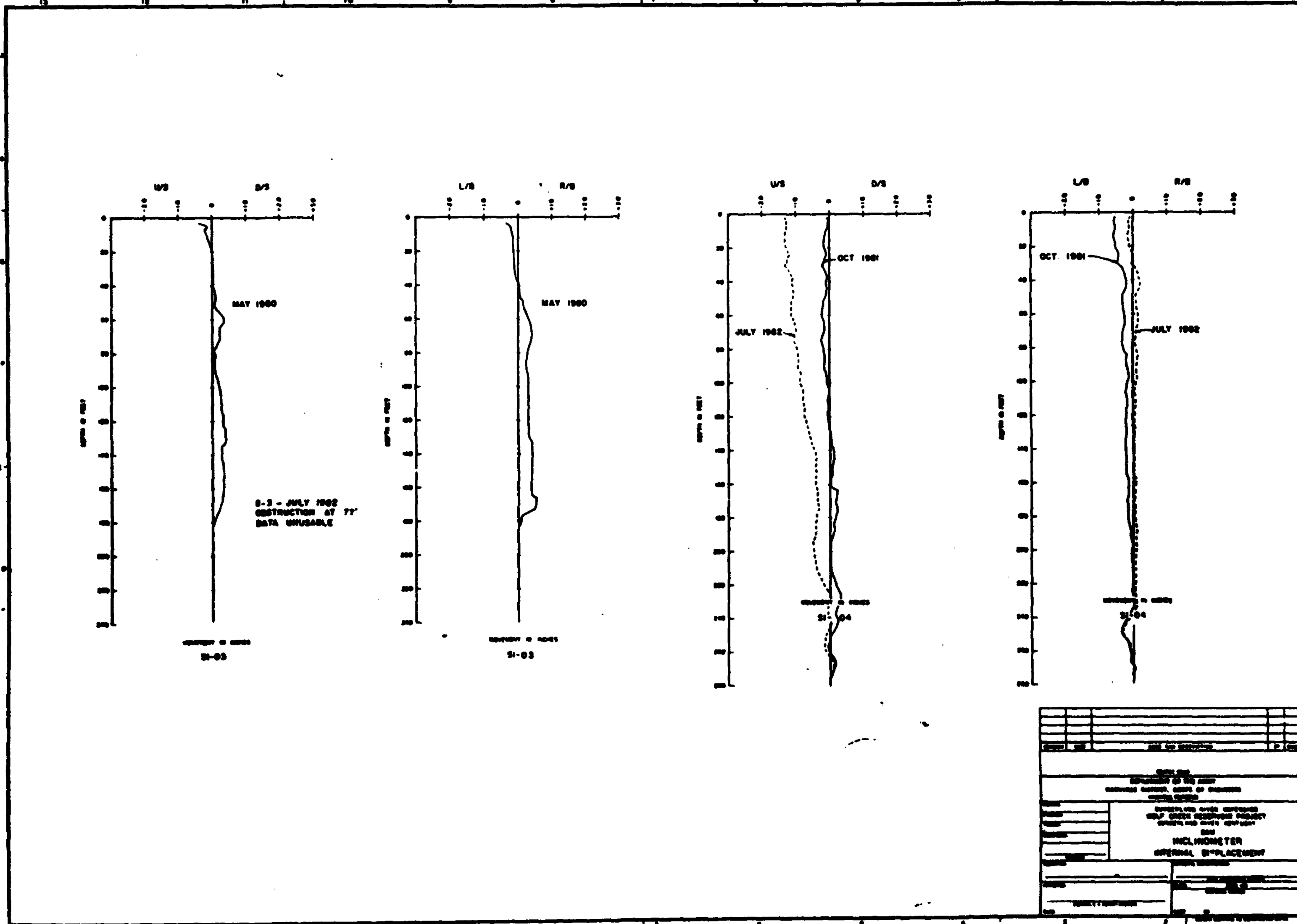
WOLF CREEK RESERVOIR PROJECT

CUMBERLAND RIVER, KENTUCKY

INCLINOMETER

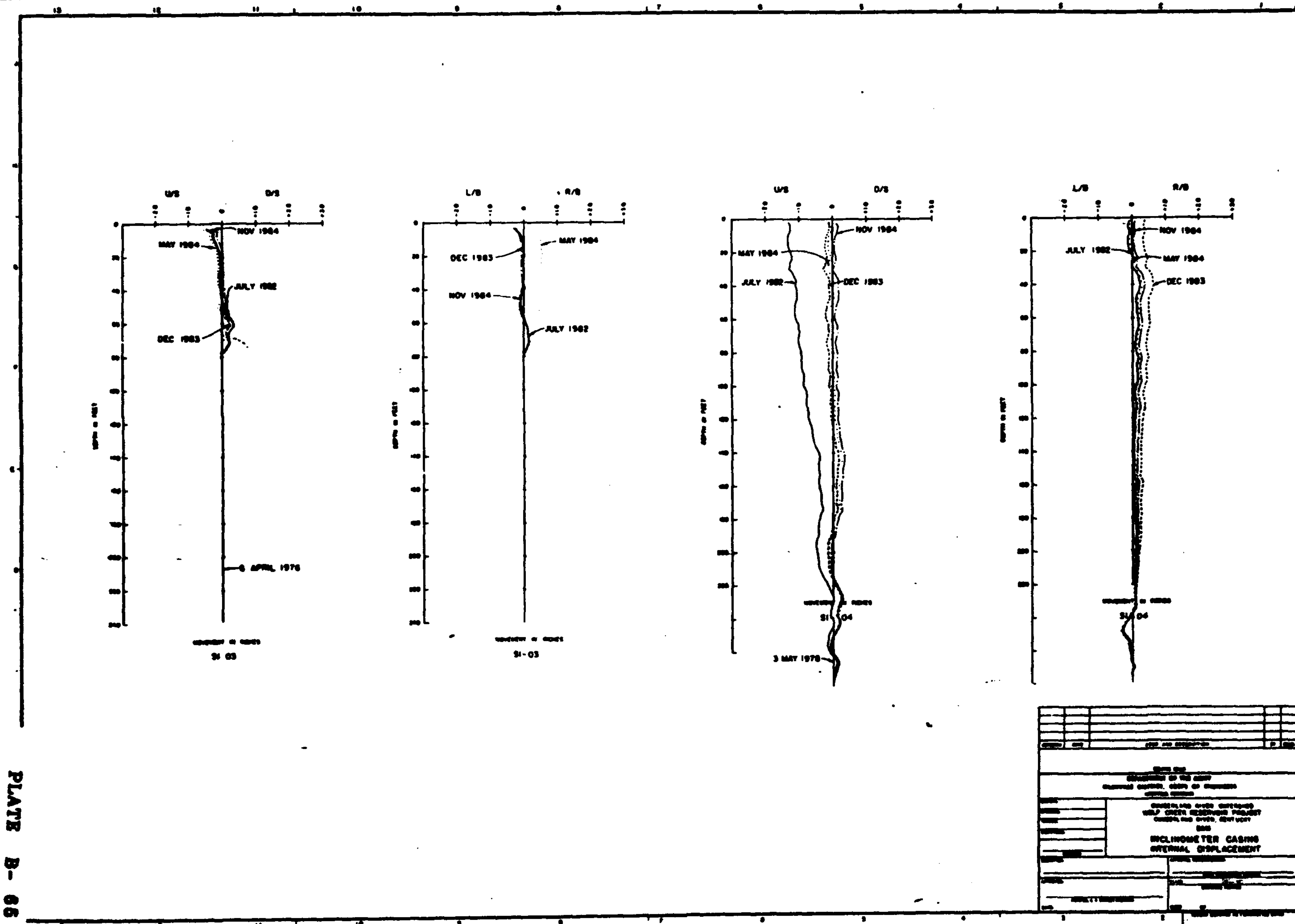
INTERNAL DISPLACEMENT

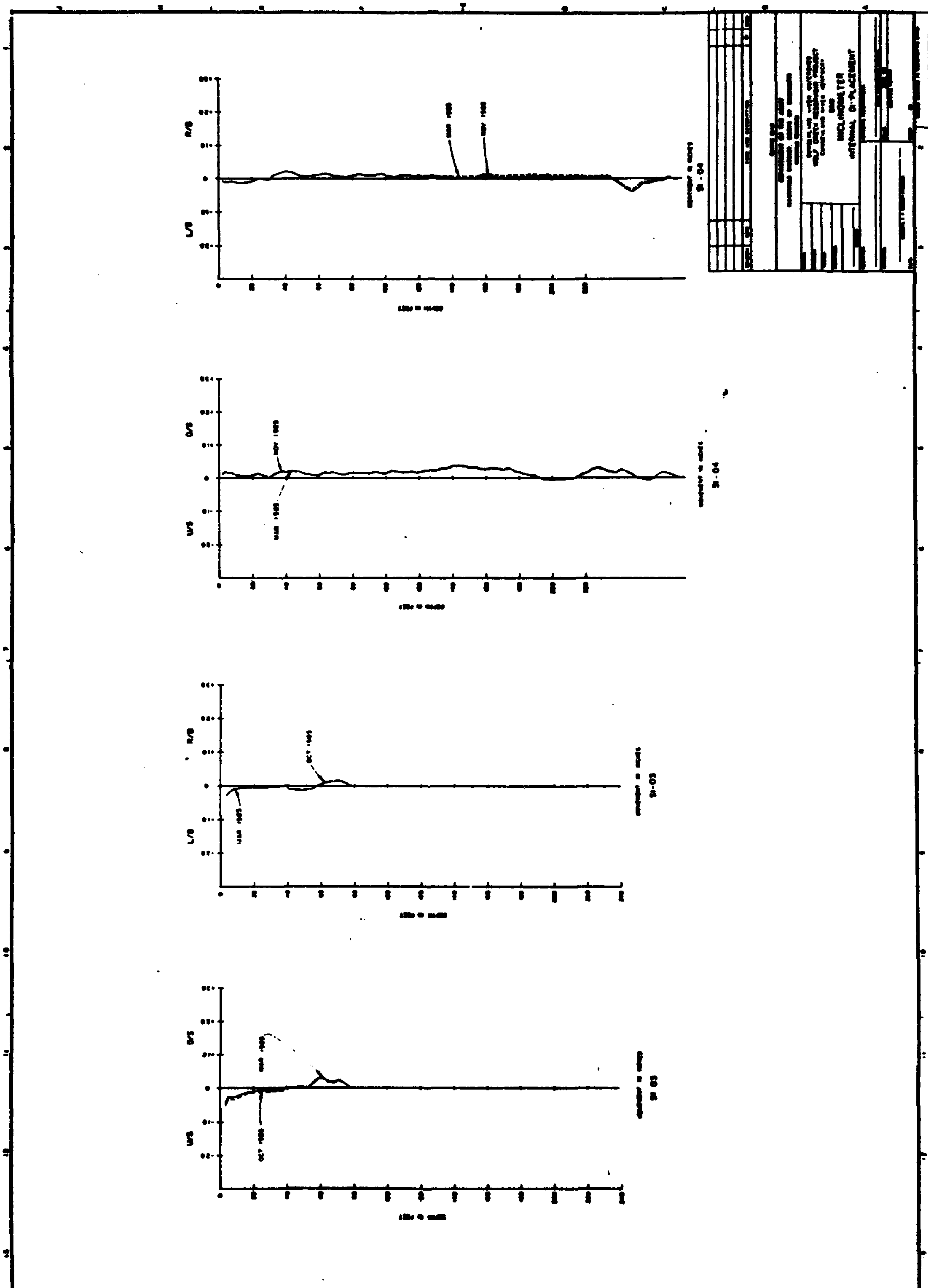
PLATE B- 63



U/S
D/S
L/B
R/B
MAY 1980
S-3 - JULY 1982
OBSTRUCTION AT 77'
DATA UNUSABLE
SI-03
OCT 1981
JULY 1982
SI-04
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 64


U/S
D/S
L/S
R/S
NOV 1984
MAY 1984
JULY 1982
DEC 1983
6 APRIL 1976
3 MAY 1976
SI 03
SI-03
SI 04
INCLINOMETER CASING
INTERNAL DISPLACEMENT
WOLF CREEK RESERVOIR PROJECT



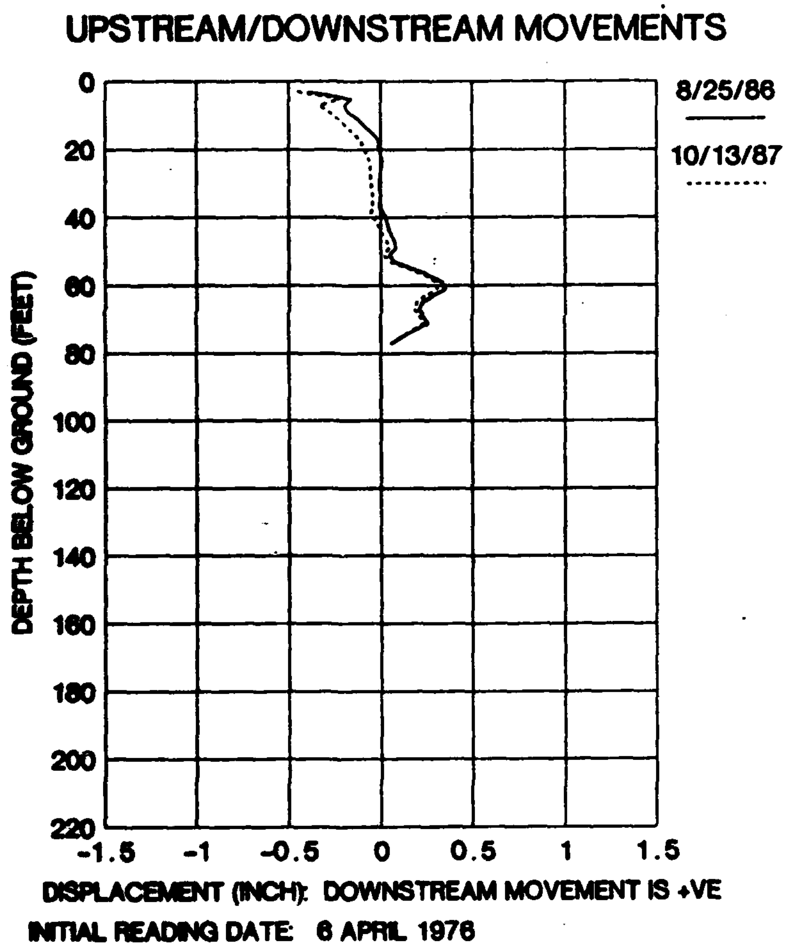
Reproduced at Government Expense-1

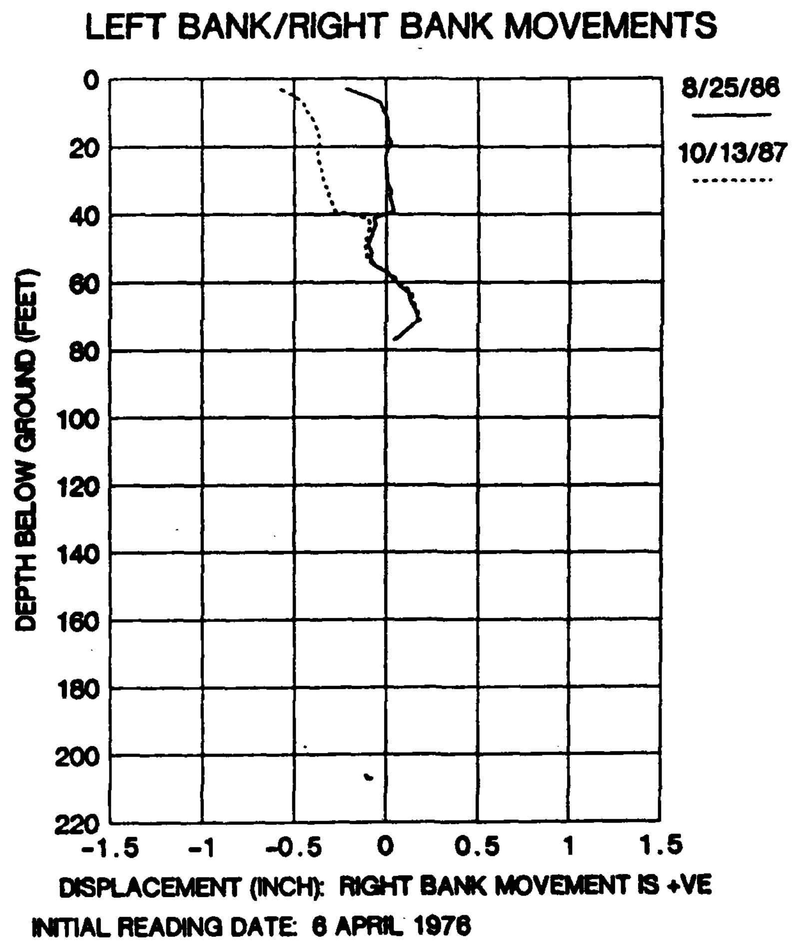
PLATE B- 66

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-03



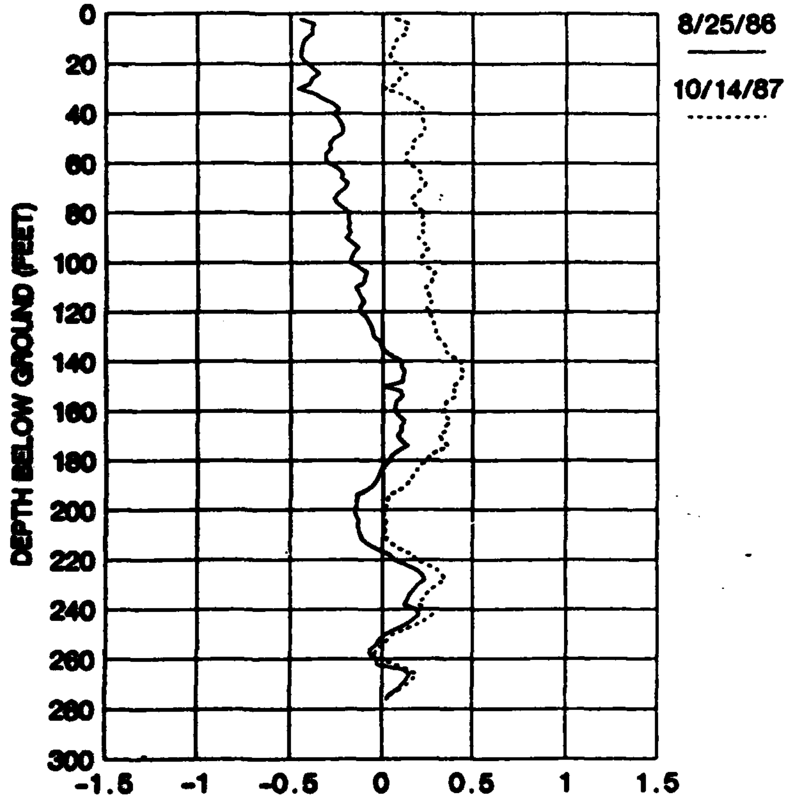


WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-04

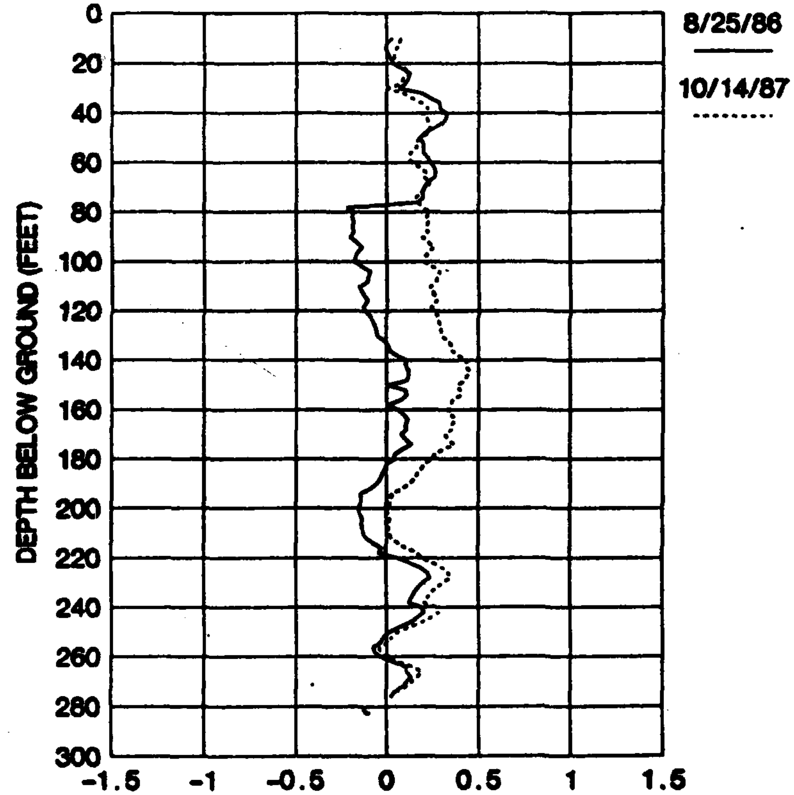
UPSTREAM/DOWNSTREAM MOVEMENTS



DISPLACEMENT (INCH): DOWNSTREAM MOVEMENT IS +VE

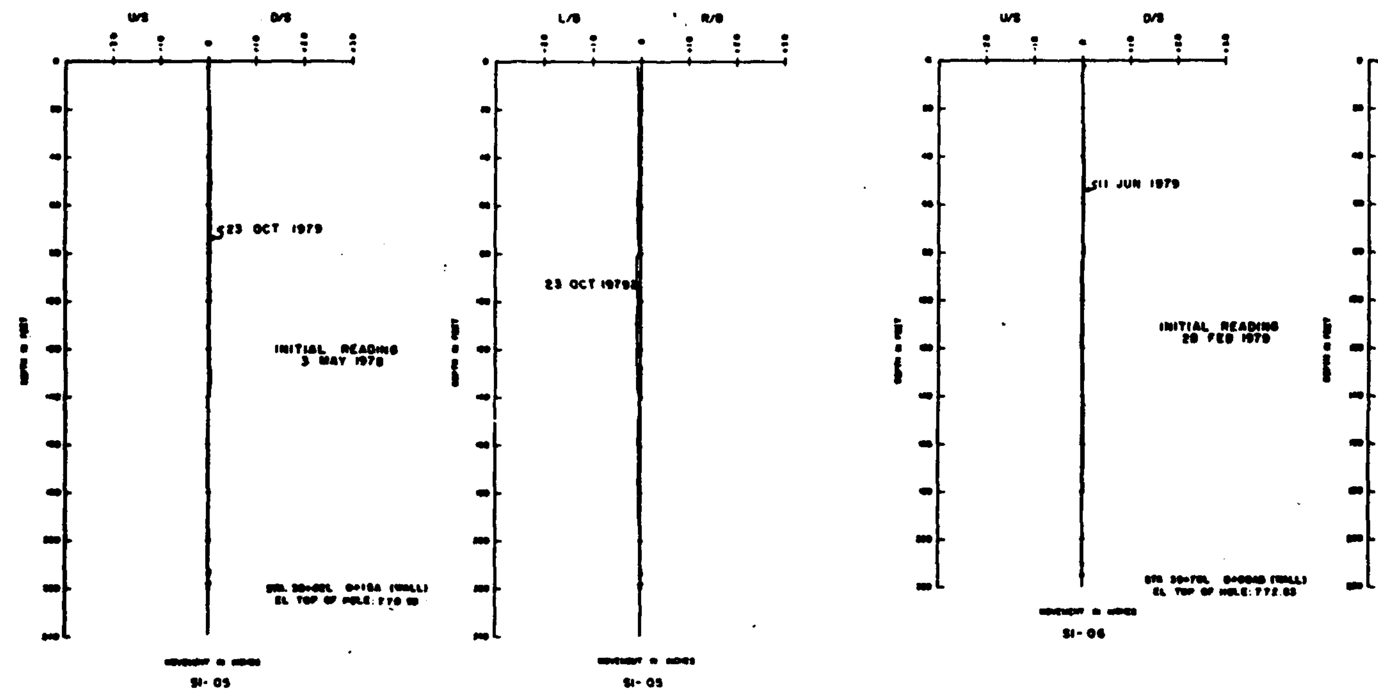
INITIAL READING DATE: 3 MAY 1978

LEFT BANK/RIGHT BANK MOVEMENTS



DISPLACEMENT (INCH): RIGHT BANK MOVEMENT IS +VE

INITIAL READING DATE: 3 MAY 1978



NOTES:
1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION
2. FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATION DRAWING

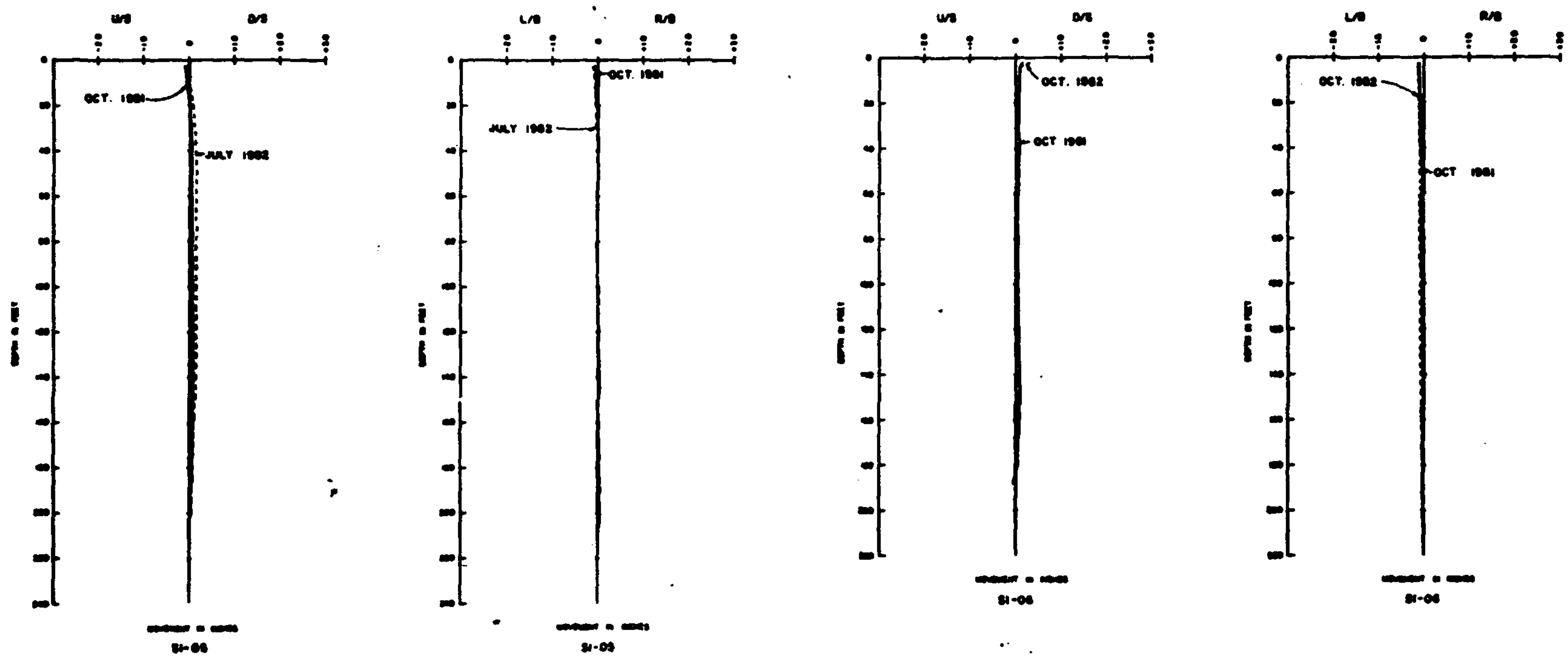
DEPARTMENT OF THE ARMY

WOLF CREEK RESERVOIR PROJECT

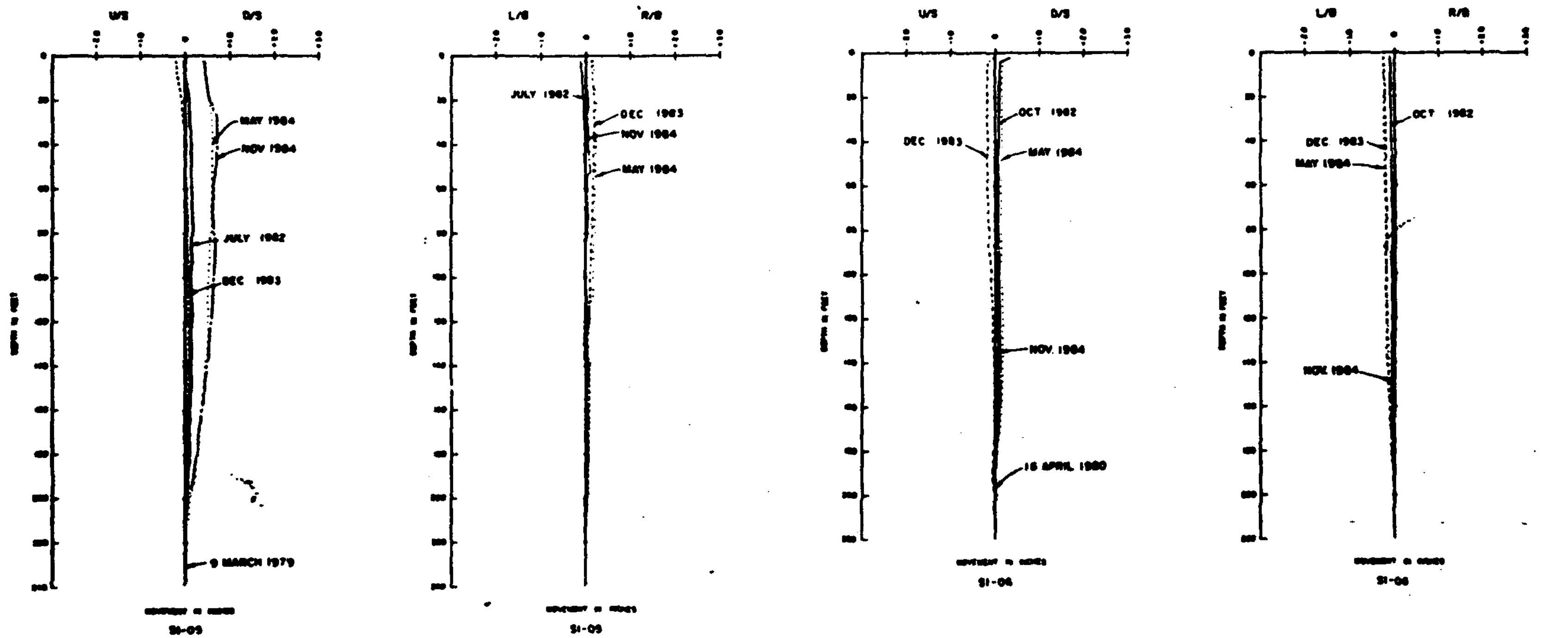
INCLINOMETER

INTERNAL DISPLACEMENT

PLATE B- 69



INCLINOMETER
INTERNAL DISPLACEMENT



INCLINOMETER CASING
INTERNAL DISPLACEMENT

PLATE B- 71

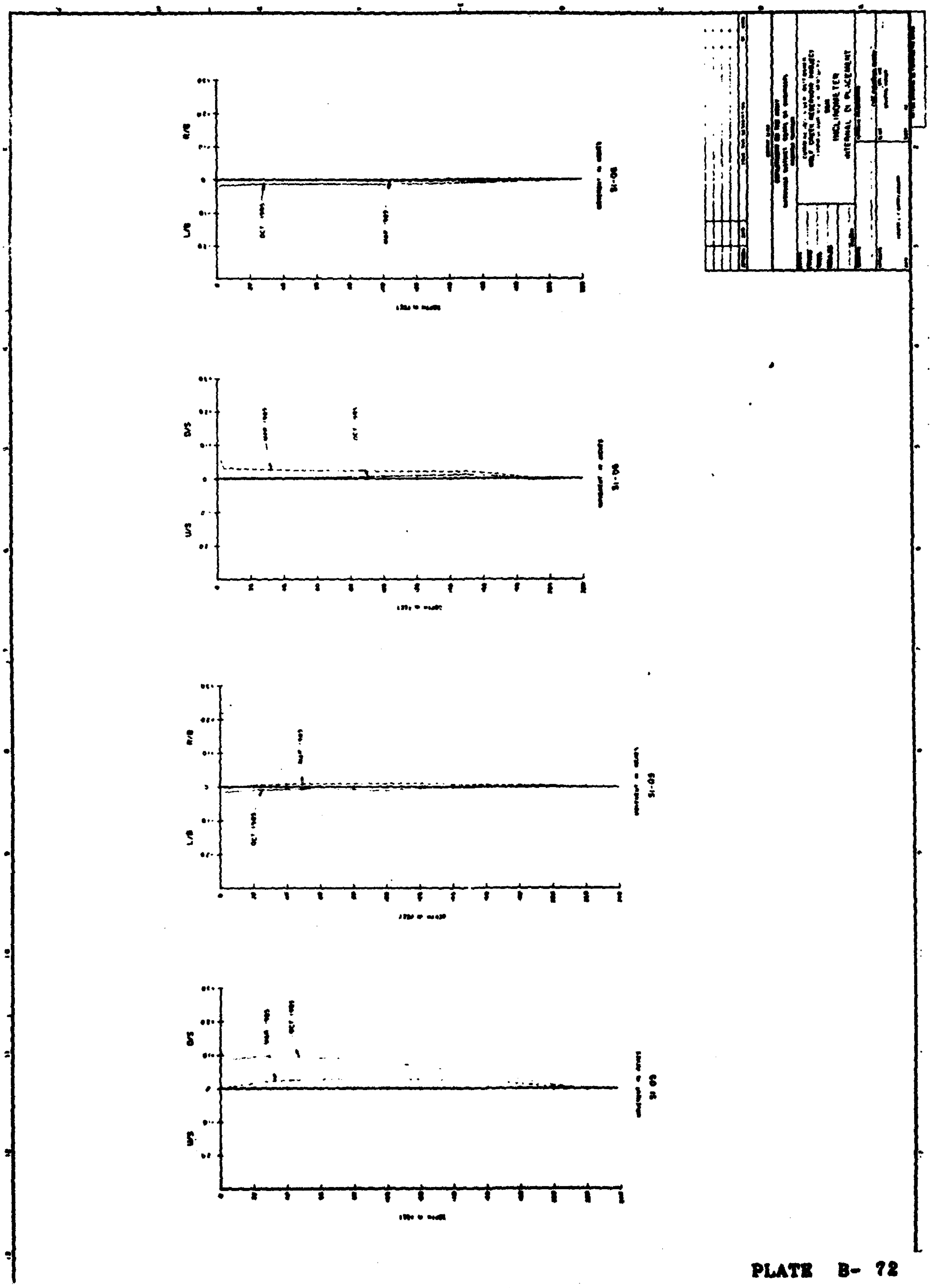
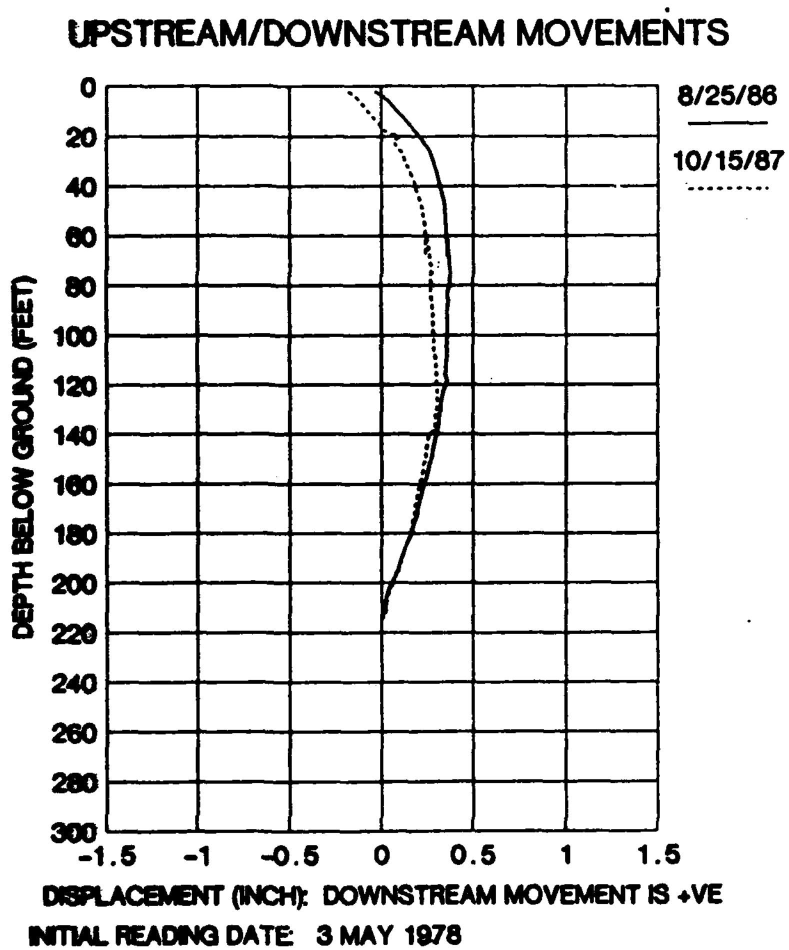


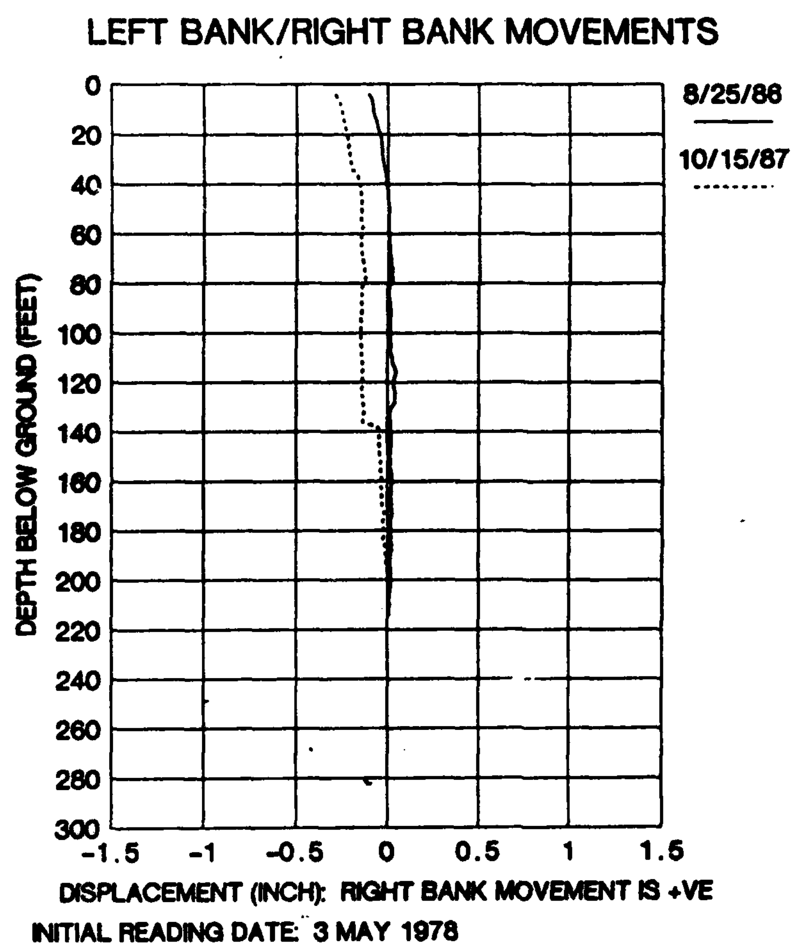
PLATE B- 72

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-05

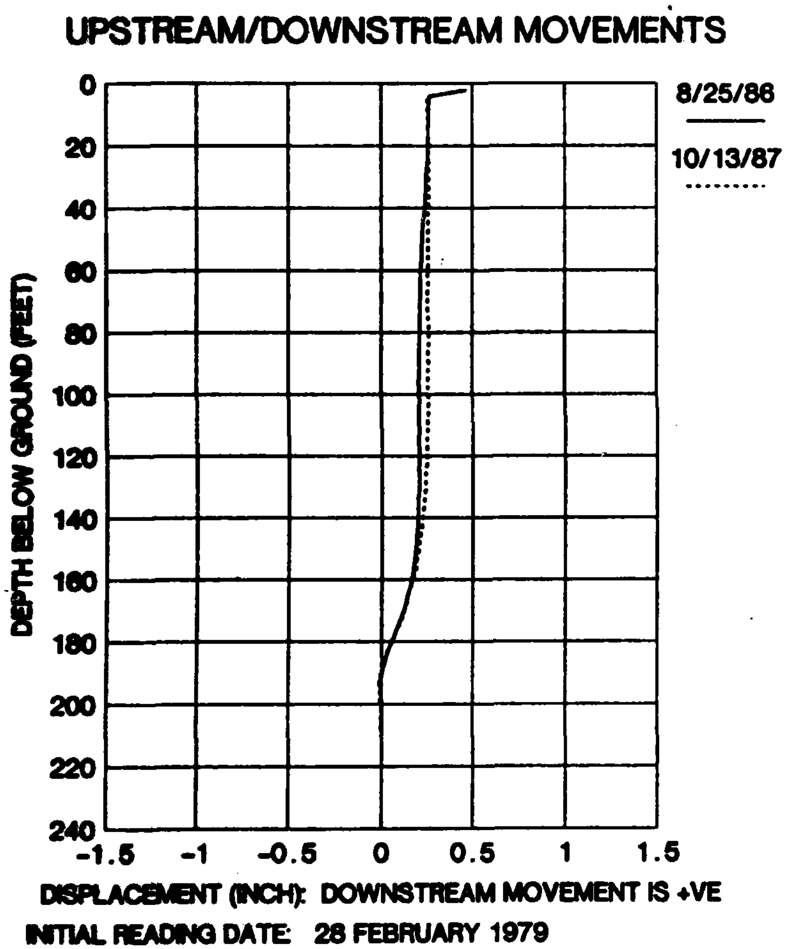


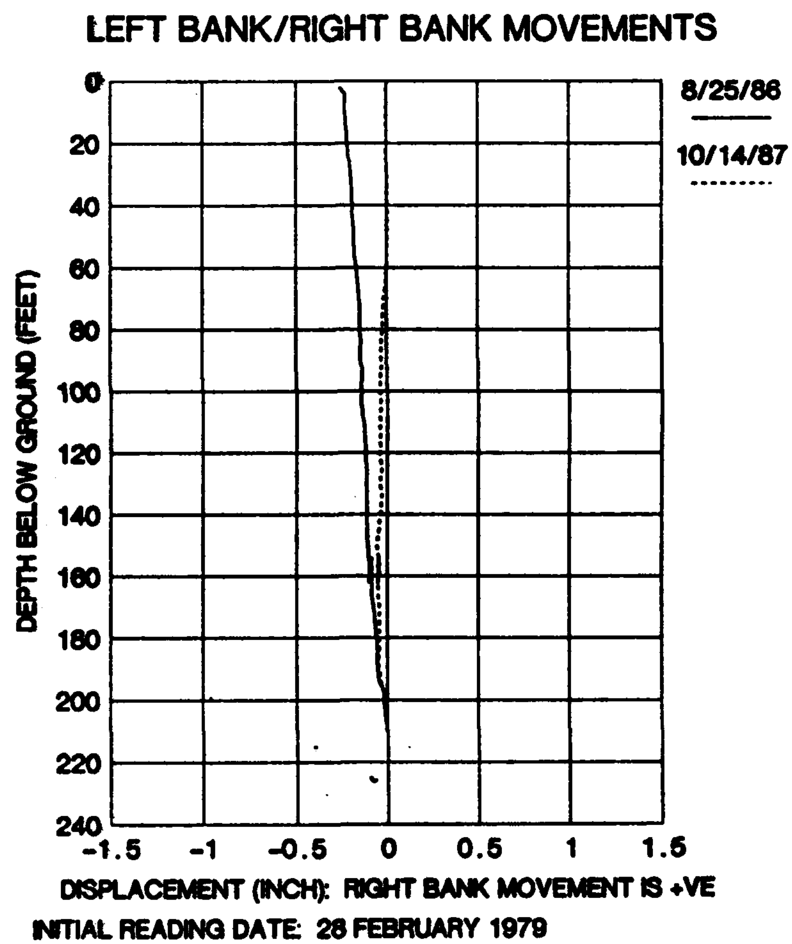


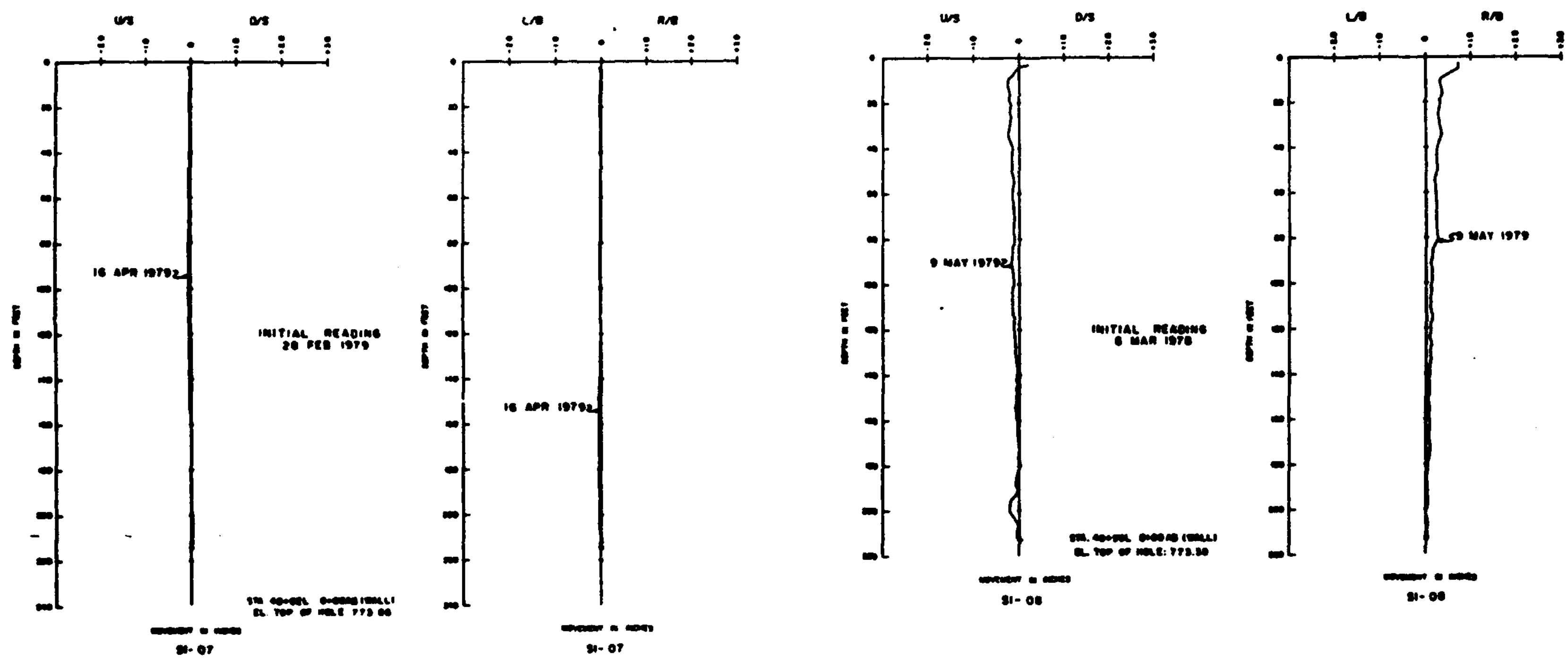
WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-06







NOTES:

1 PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION

2 FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING

WOLF CREEK RESERVOIR PROJECT

DAM

INCLINOMETER

INTERNAL DISPLACEMENT

PLATE B- 75

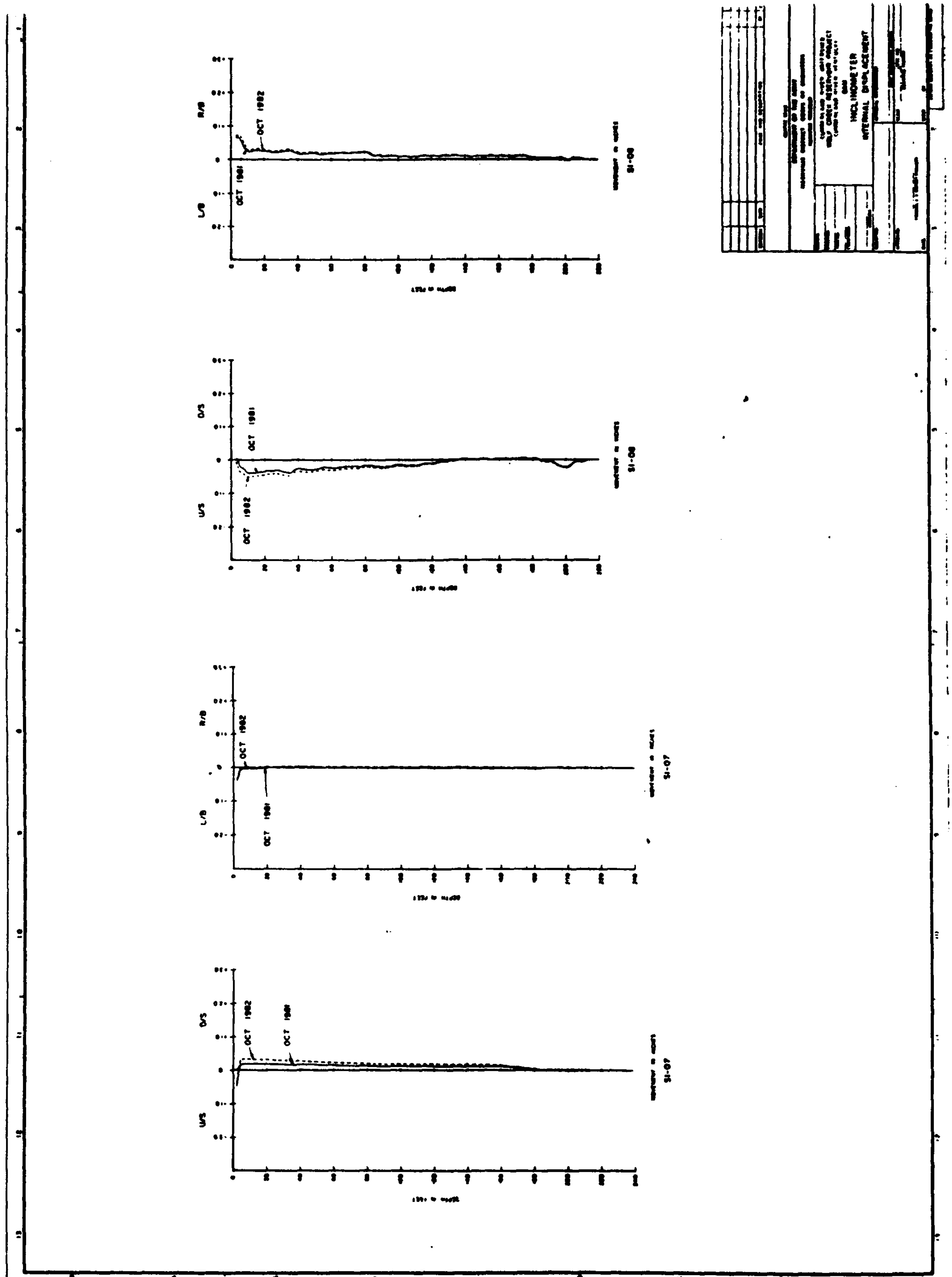
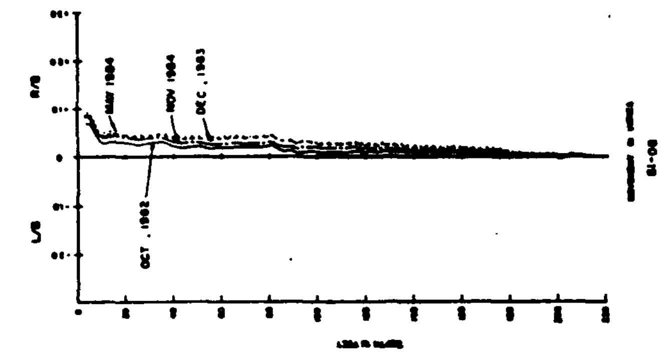
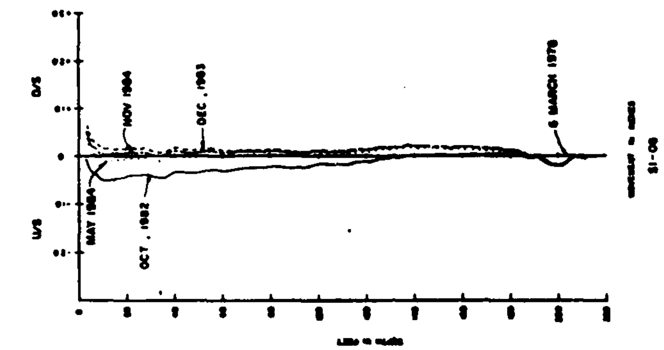
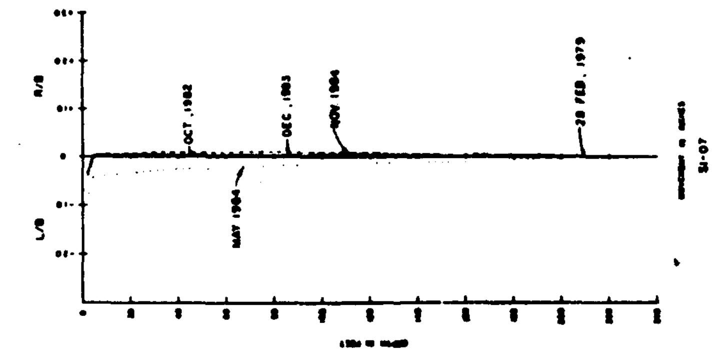

R/B
L/B
OCT 1982
OCT 1981
SI-08
D/S
U/S
OCT 1981
OCT 1982
SI-08
R/B
L/B
OCT 1982
OCT 1981
SI-07
D/S
U/S
OCT 1982
OCT 1981
SI-07
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 76


MAY 1984
NOV 1984
DEC. 1983
OCT. 1982


NOV 1984
DEC. 1983
6 MARCH 1978
MAY 1984
OCT. 1982


OCT. 1982
DEC. 1983
NOV 1984
28 FEB. 1979
MAY 1984
SI-07

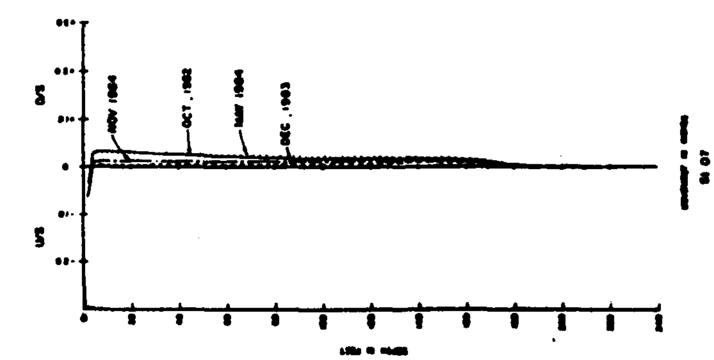

NOV 1984
OCT. 1982
MAY 1984
DEC. 1983
SI-07

PLATE B- 77

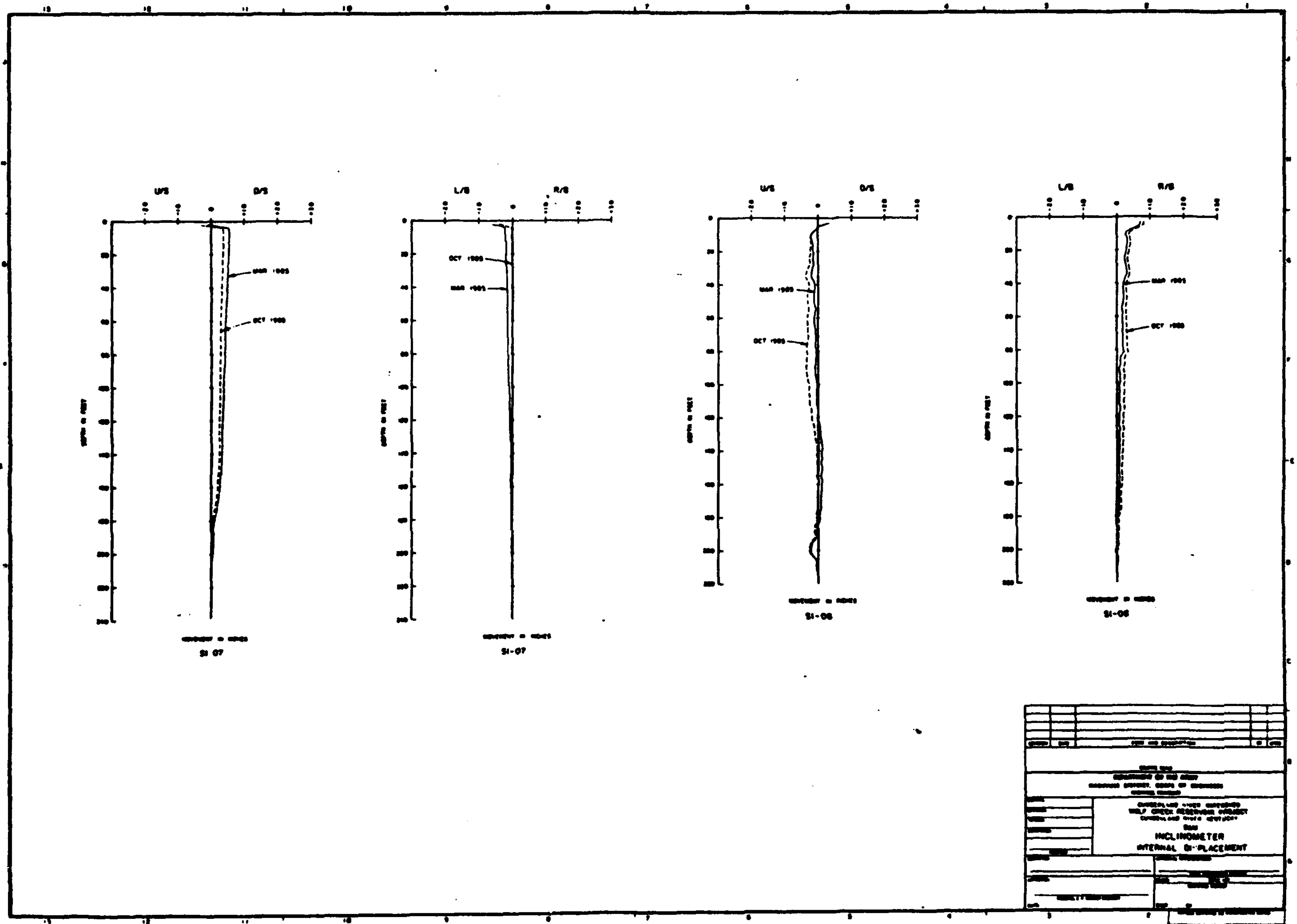
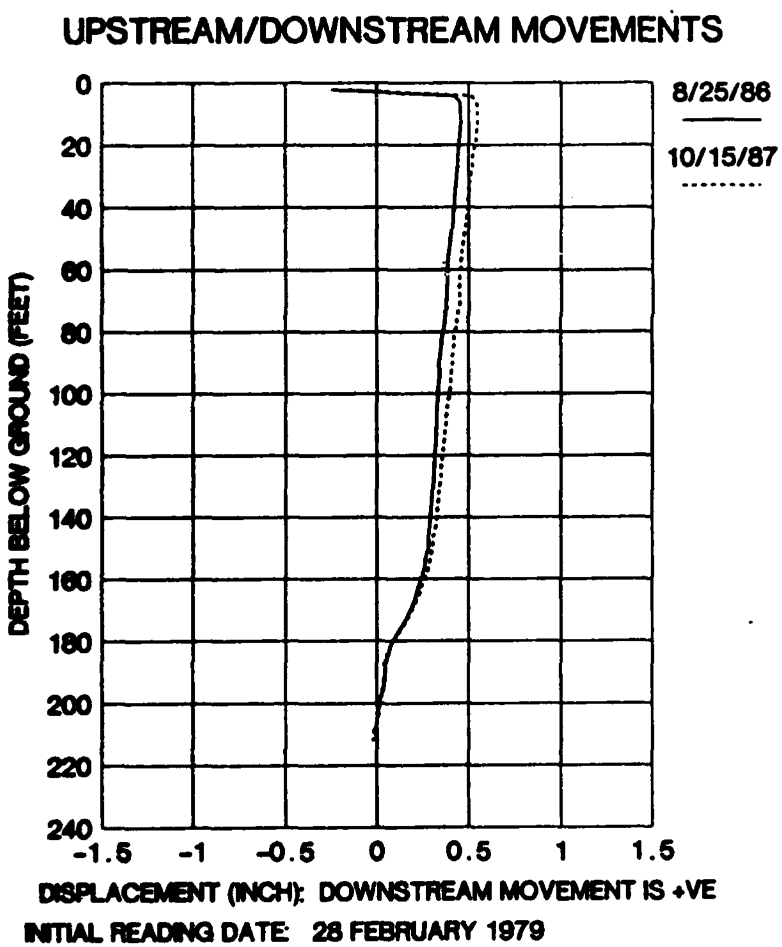

U/S
D/S
L/S
R/S
SI-07
SI-07
SI-06
SI-06
INCLINOMETER
INTERNAL DISPLACEMENT

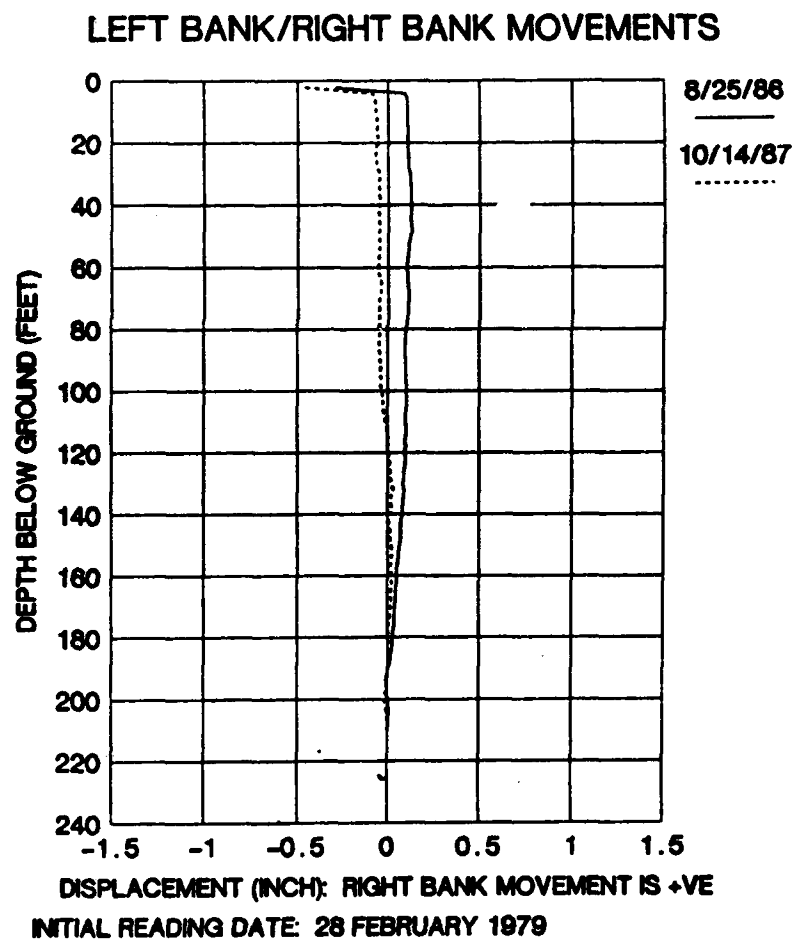
PLATE B- 78

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-07



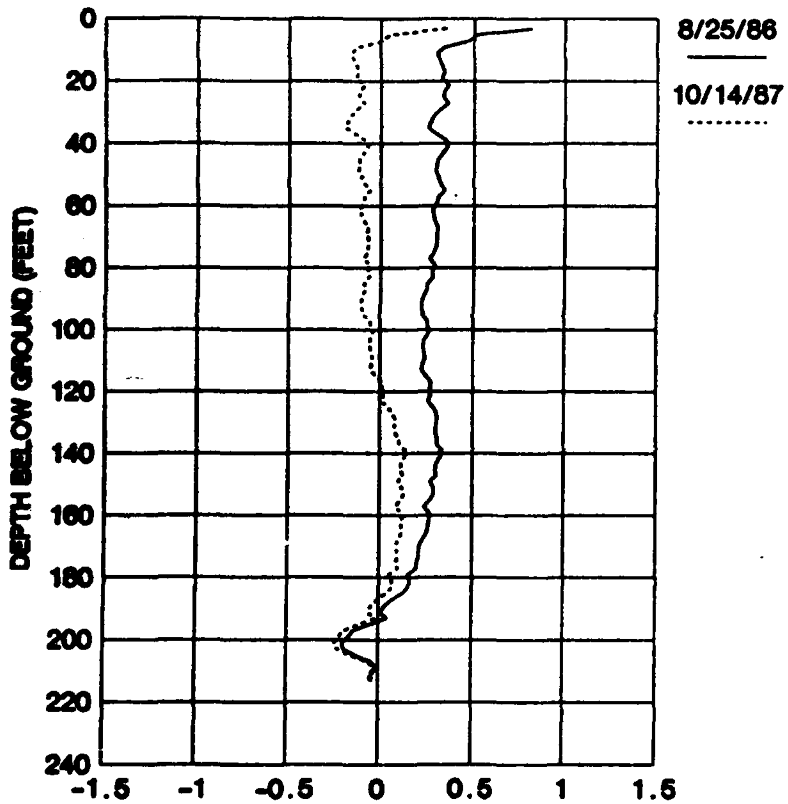


WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-08

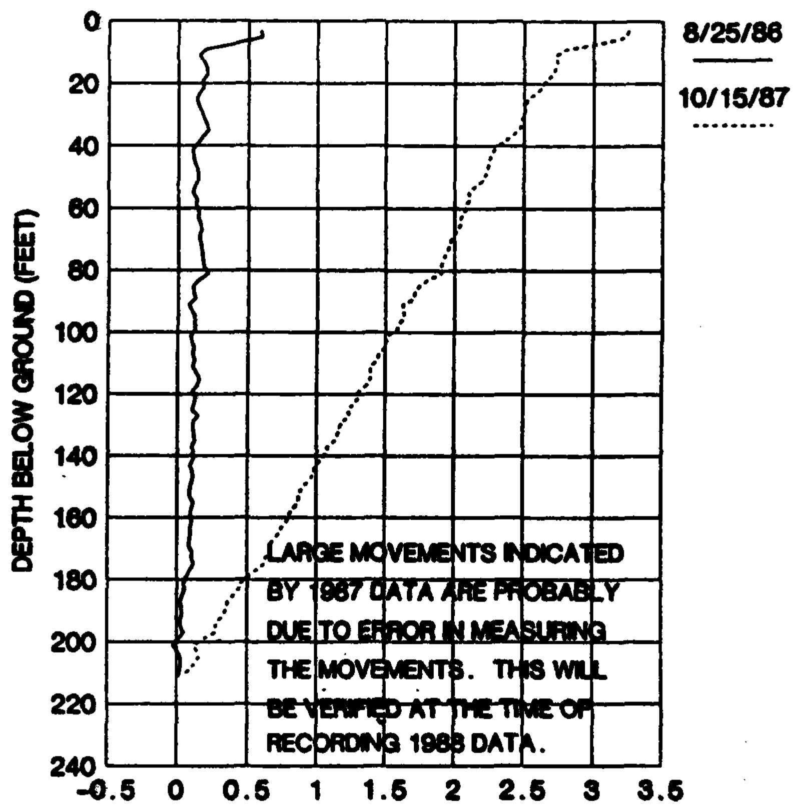
UPSTREAM/DOWNSTREAM MOVEMENTS



DISPLACEMENT (INCH): DOWNSTREAM MOVEMENT IS +VE

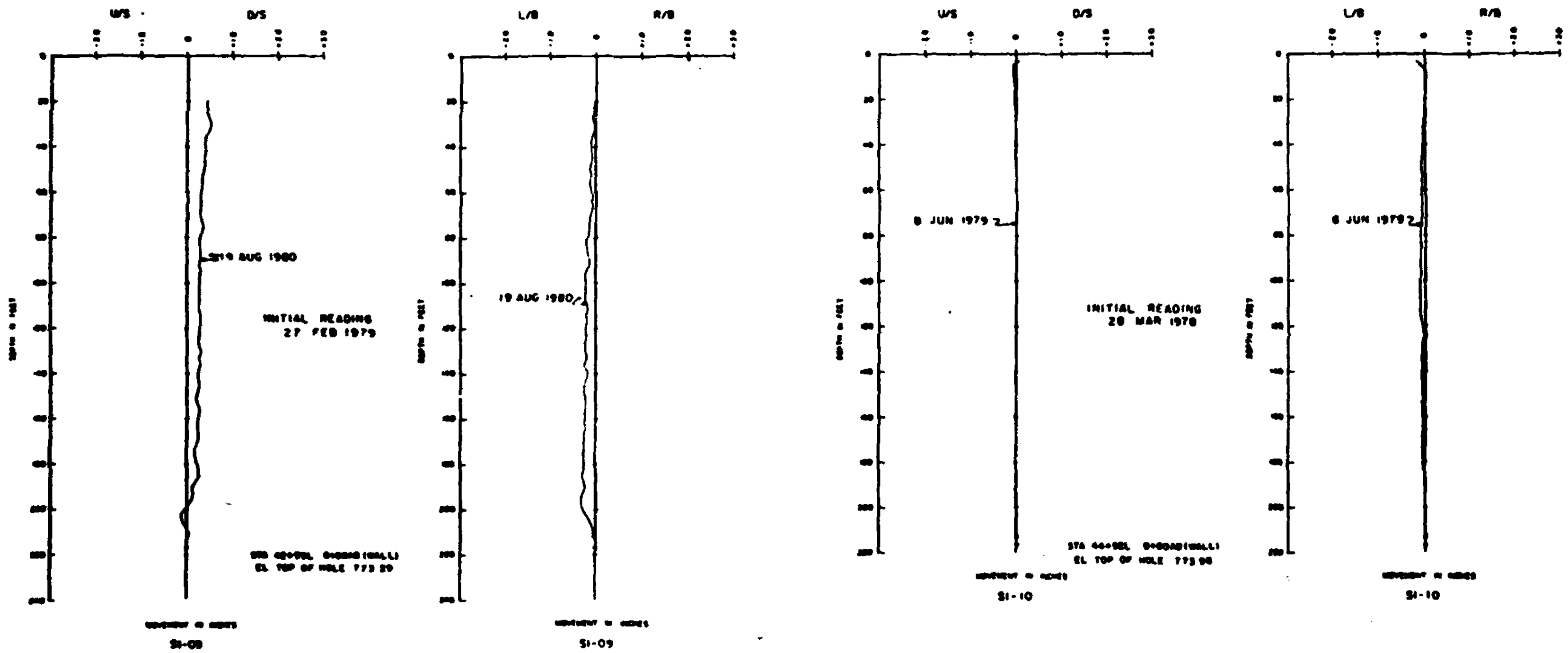
INITIAL READING DATE: 6 MARCH 1978

LEFT BANK/RIGHT BANK MOVEMENTS



DISPLACEMENT (INCH): RIGHT BANK MOVEMENT IS +VE

INITIAL READING DATE: 6 MARCH 1978



NOTES

1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION
2. FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING

DEPARTMENT OF THE ARMY

CORPS OF ENGINEERS

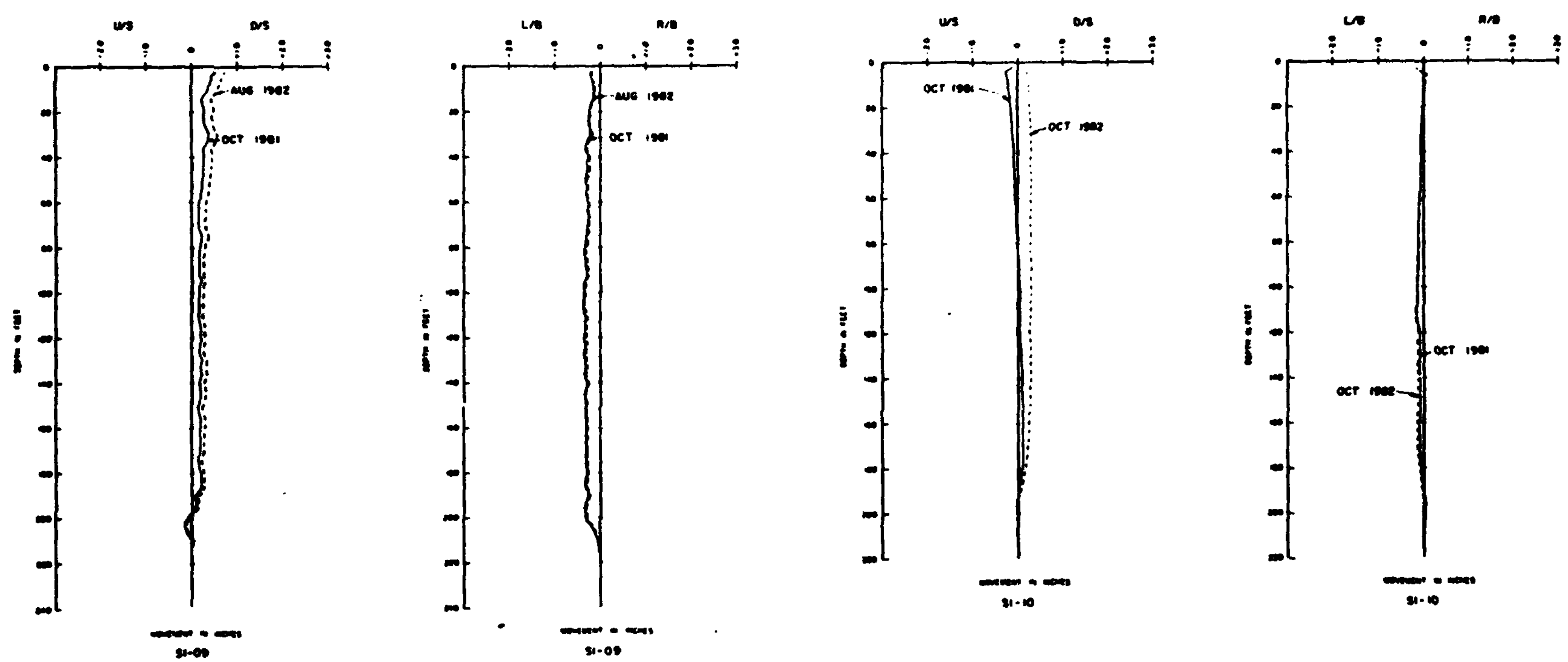
WOLF CREEK RESERVOIR PROJECT

DAM

INCLINOMETER

INTERNAL DISPLACEMENT

PLATE B- 81

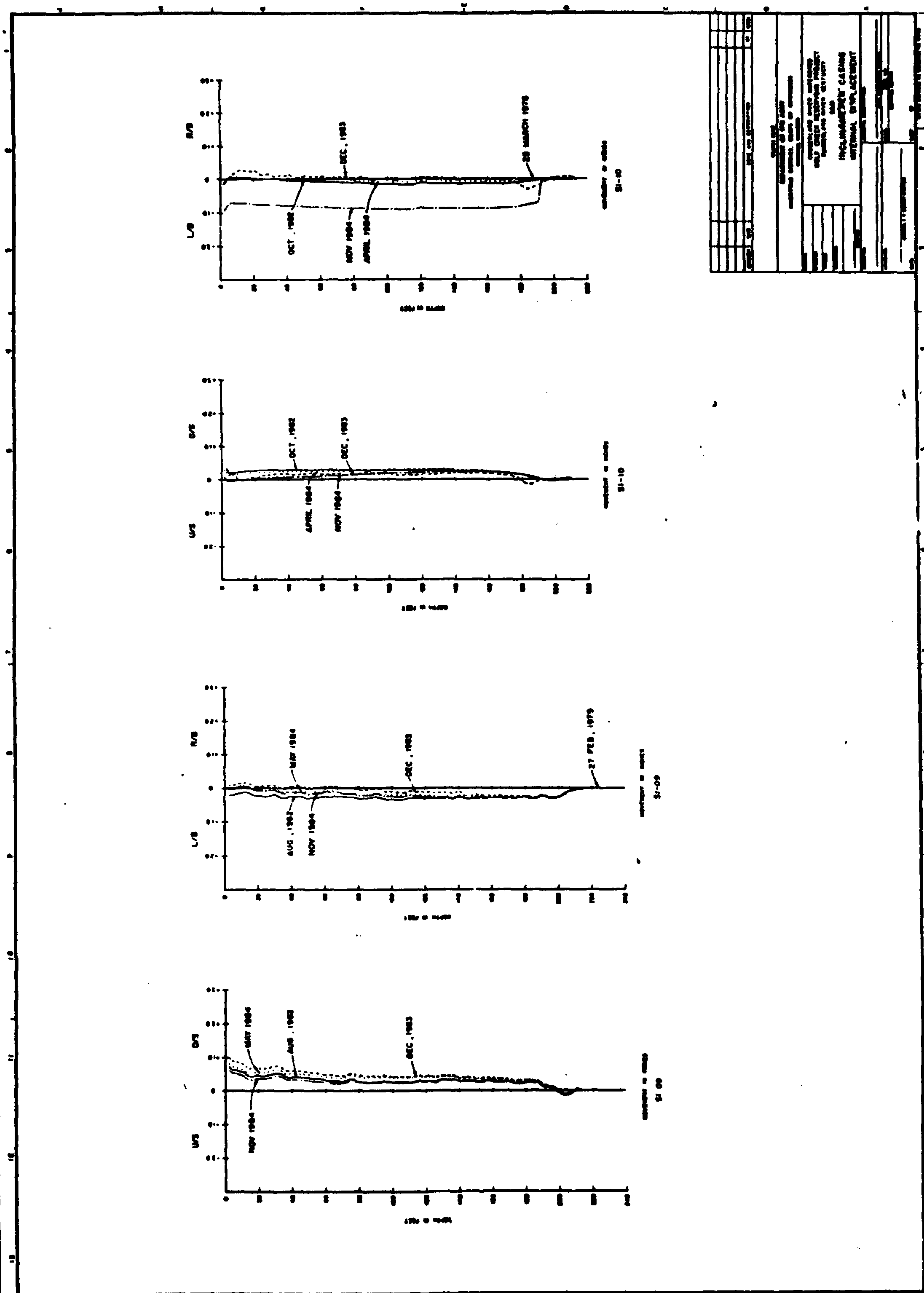


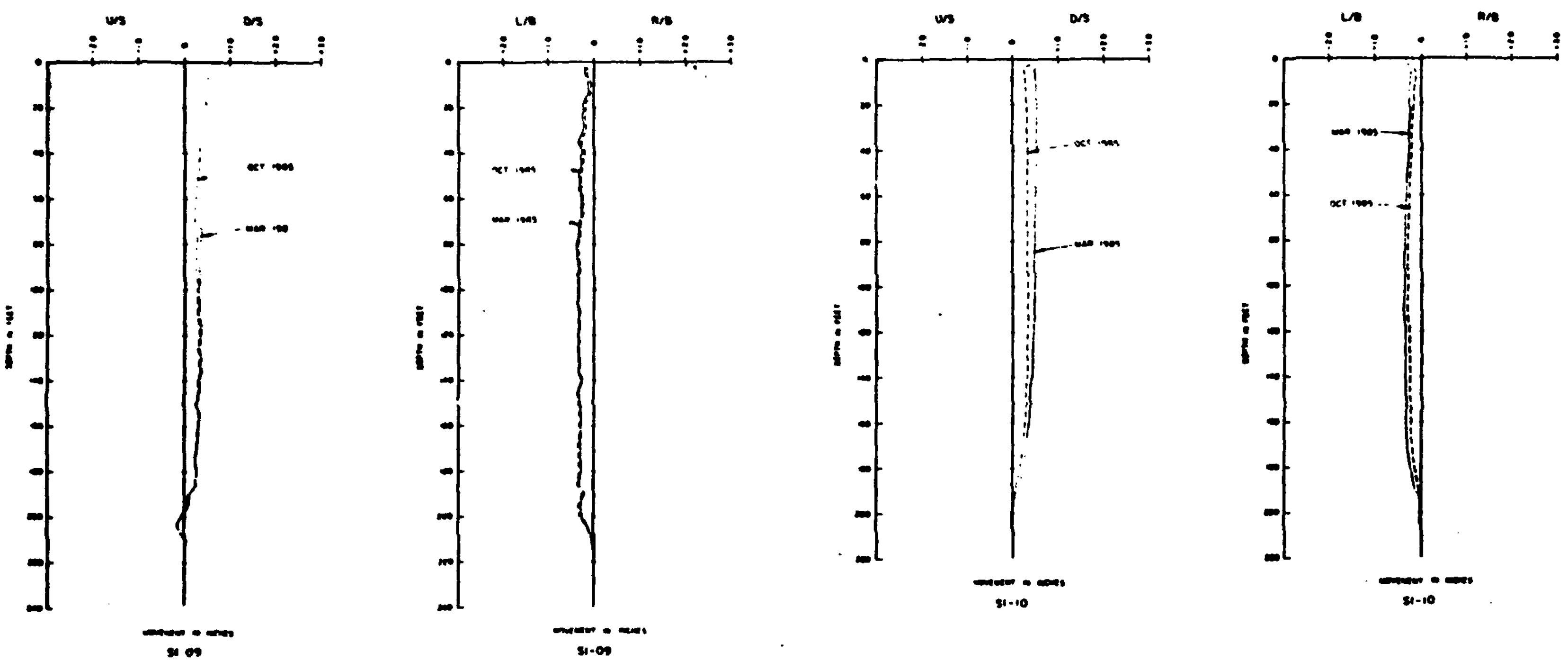
WOLF CREEK RESERVOIR PROJECT

INCLINOMETER

INTERNAL DISPLACEMENT

PLATE B- 82


U/S
D/S
L/S
R/S
OCT, 1982
DEC, 1983
NOV 1984
APRIL 1984
28 MARCH 1978
SI-10
MAY 1984
AUG, 1982
27 FEB, 1979
SI-09
INCLINOMETER CASING
INTERNAL DISPLACEMENT



DEPARTMENT OF THE ARMY

WOLF CREEK RESERVOIR PROJECT

DAM

INCLINOMETER

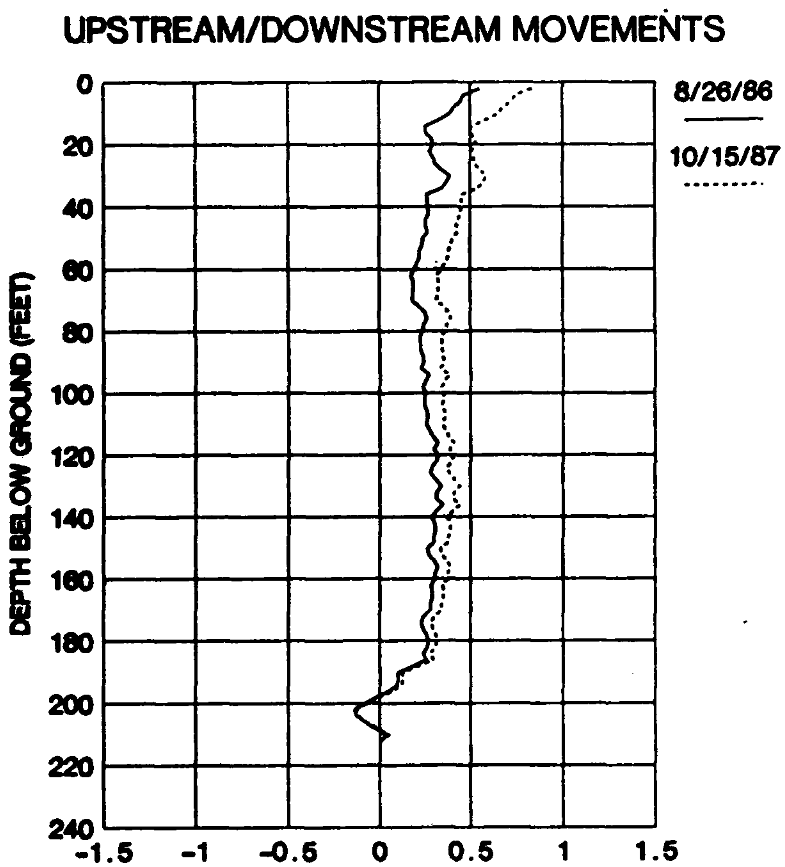
INTERNAL DISPLACEMENT

PLATE B- 84

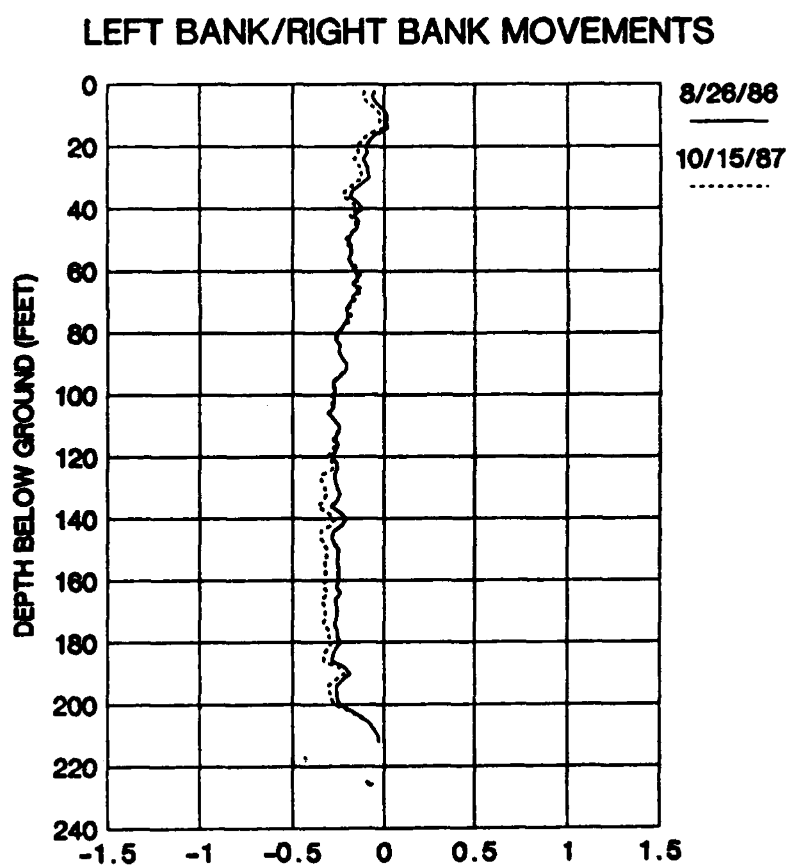
WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-09



DISPLACEMENT (INCH): DOWNSTREAM MOVEMENT IS +VE
INITIAL READING DATE: 27 FEBRUARY 1979

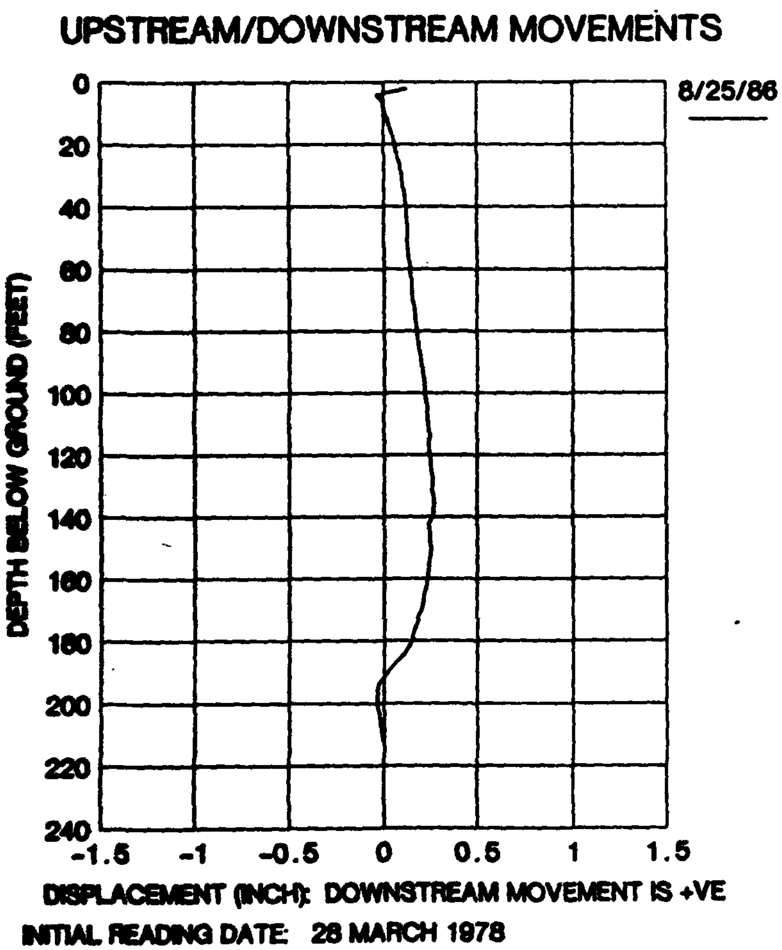


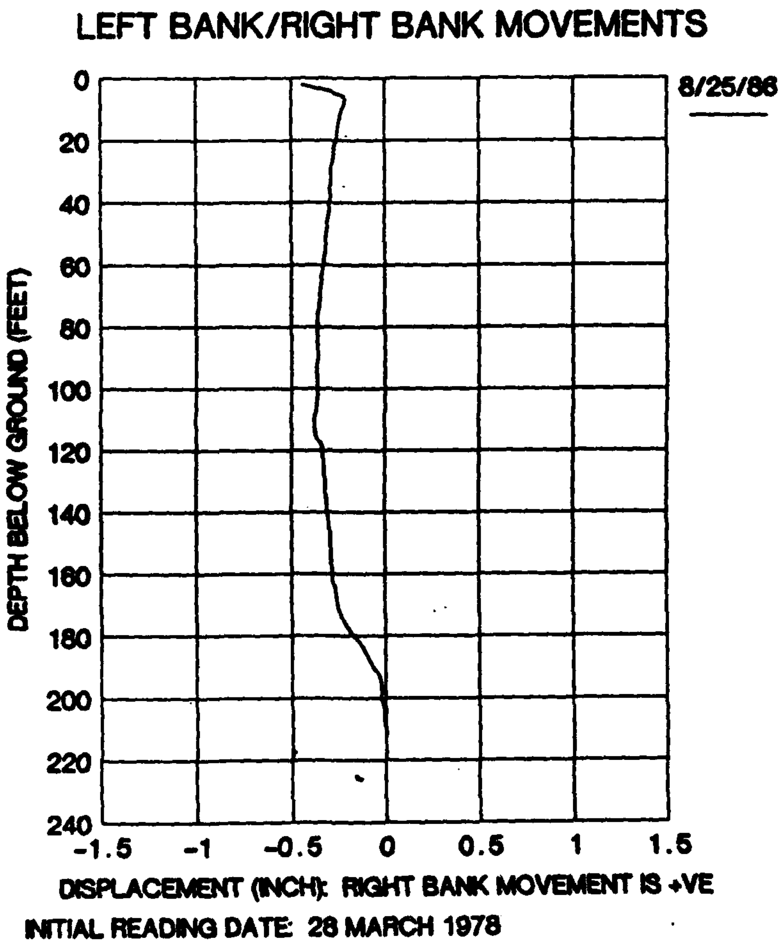
DISPLACEMENT (INCH): RIGHT BANK MOVEMENT IS +VE
INITIAL READING DATE: 27 FEBRUARY 1979

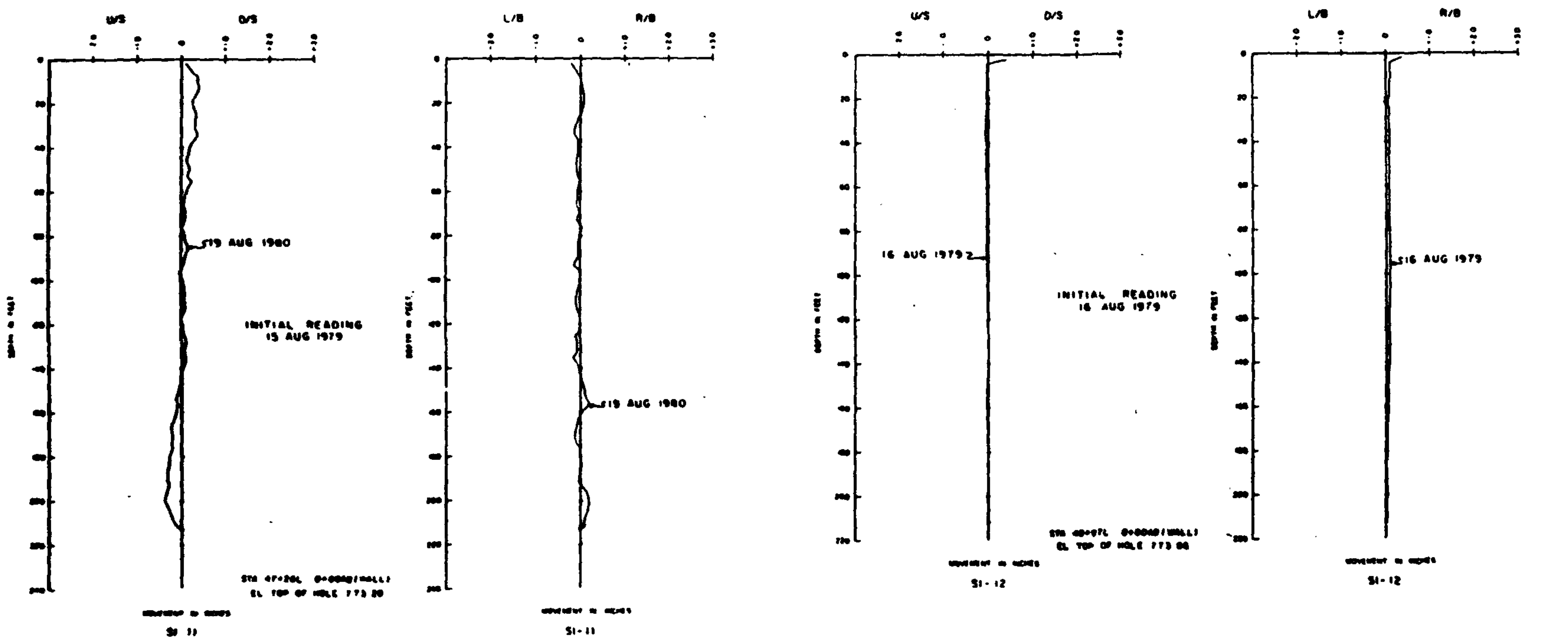
WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-10







NOTES

1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION
2. FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING

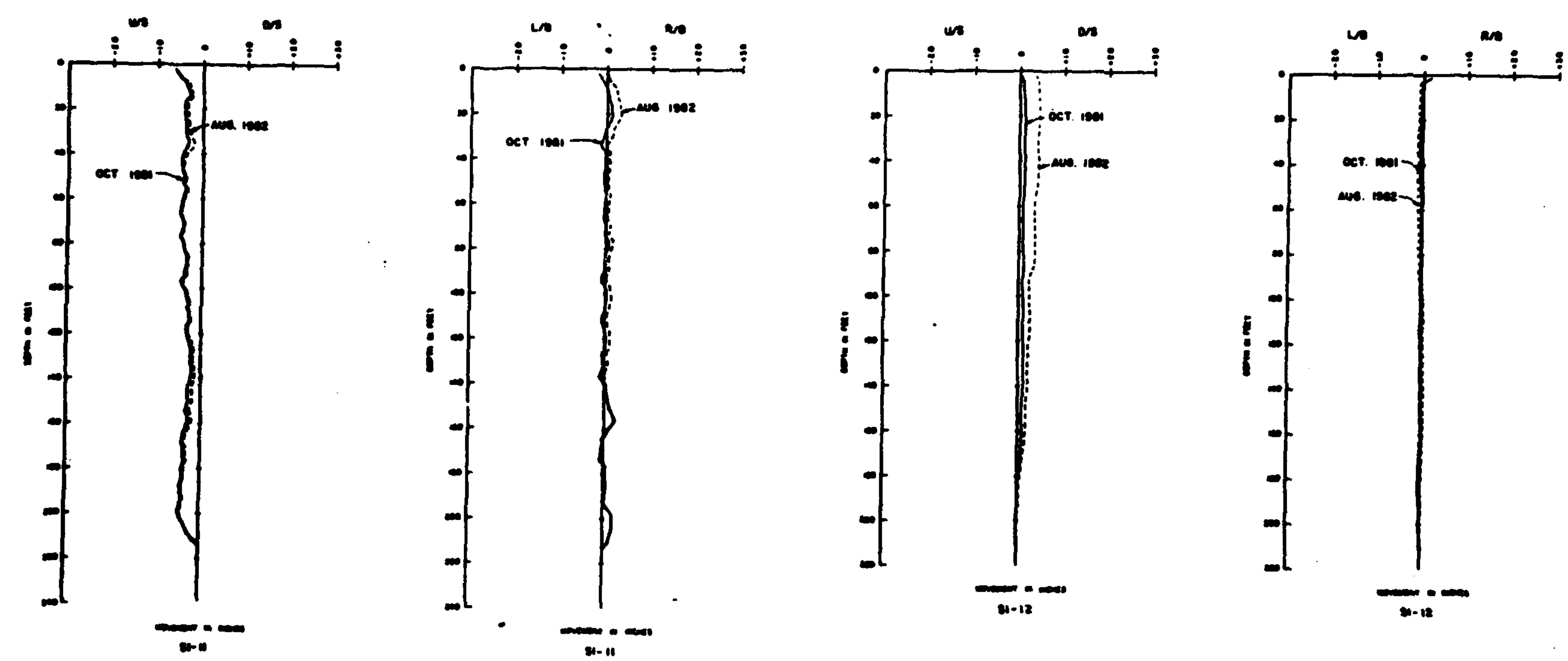
DEPARTMENT OF THE ARMY

WOLF CREEK RESERVOIR PROJECT

DAM

INCLINOMETER

INTERNAL DISPLACEMENT



WOLF CREEK RESERVOIR PROJECT
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 88

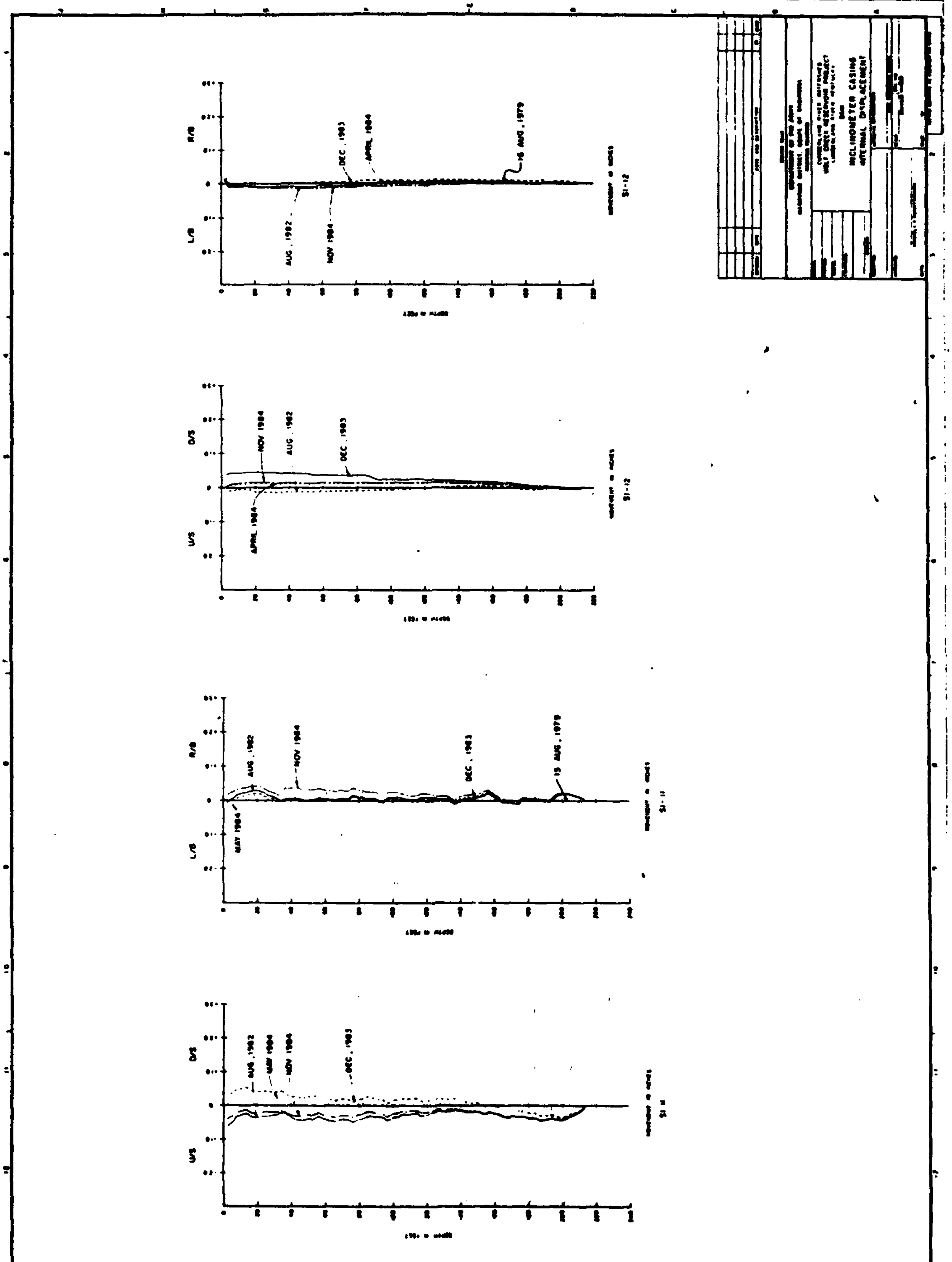

INCLINOMETER CASING
INTERNAL DISPLACEMENT
R/B
L/B
D/S
U/S
AUG, 1982
NOV 1984
DEC, 1983
APRIL 1984
15 AUG, 1979
MAY 1984
SI-12
SI-11

PLATE B- 89

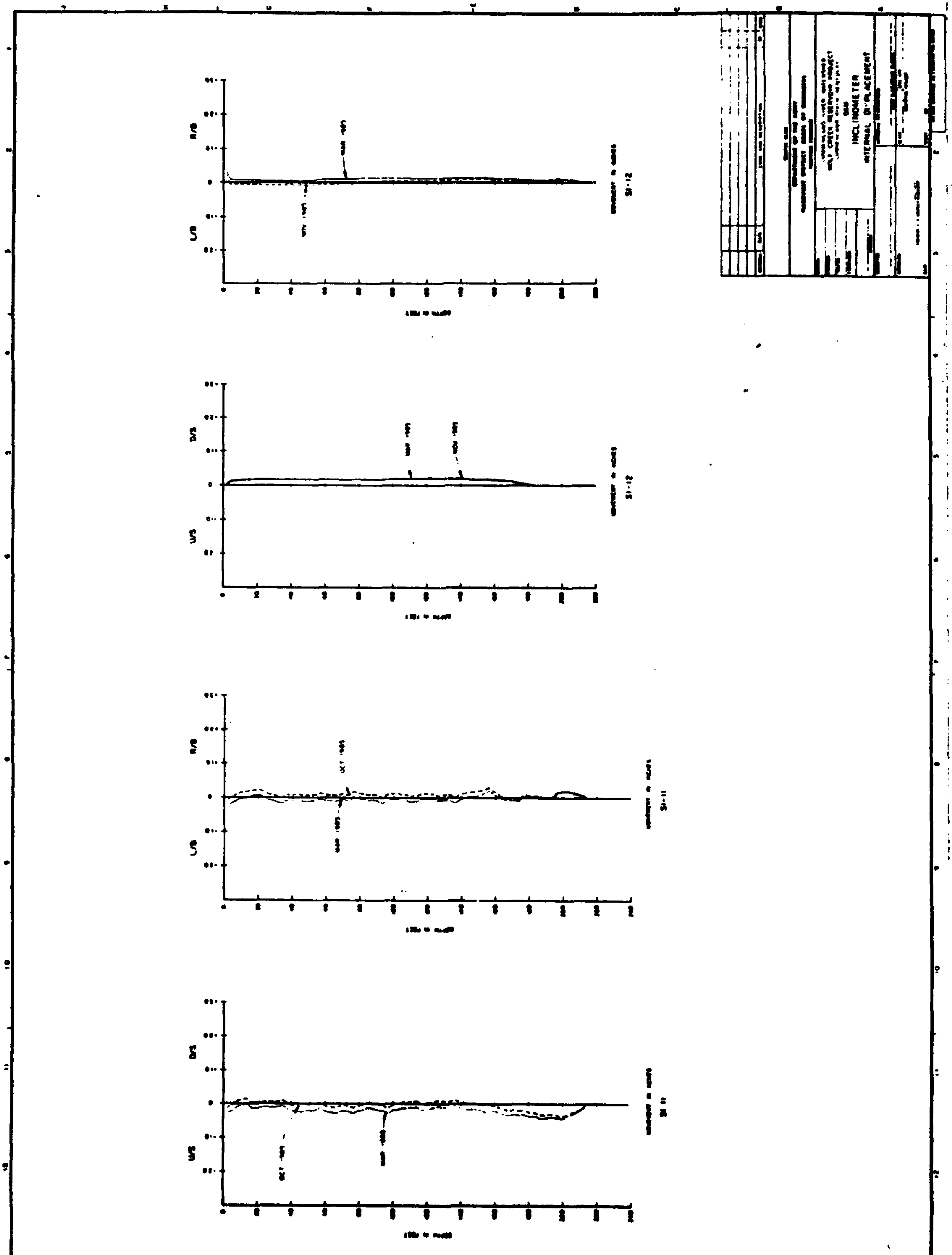

INCLINOMETER
INTERNAL DISPLACEMENT
WOLF CREEK RESERVOIR PROJECT
SI-12
SI-12
SI-11
SI-11
D/S
U/S

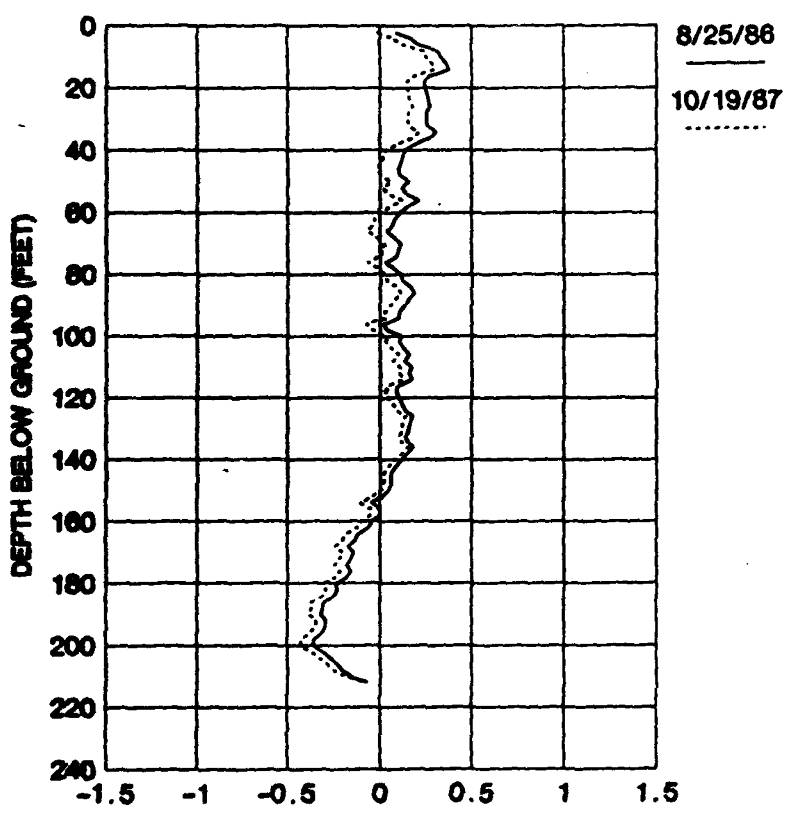
PLATE B- 90

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-11

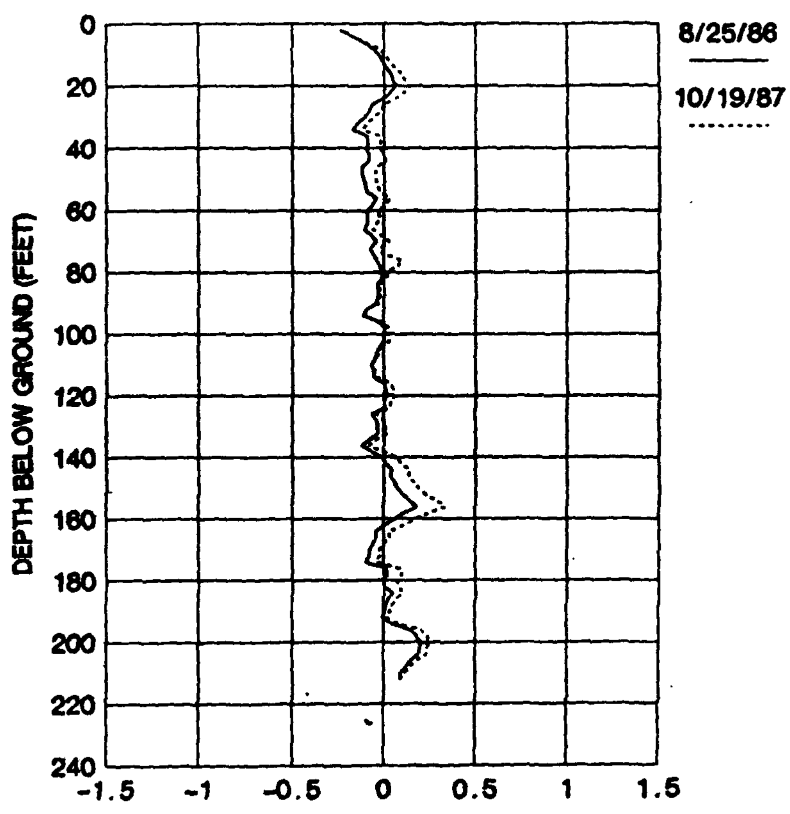
UPSTREAM/DOWNSTREAM MOVEMENTS



DISPLACEMENT (INCH): DOWNSTREAM MOVEMENT IS +VE

INITIAL READING DATE: 15 AUGUST 1979

LEFT BANK/RIGHT BANK MOVEMENTS



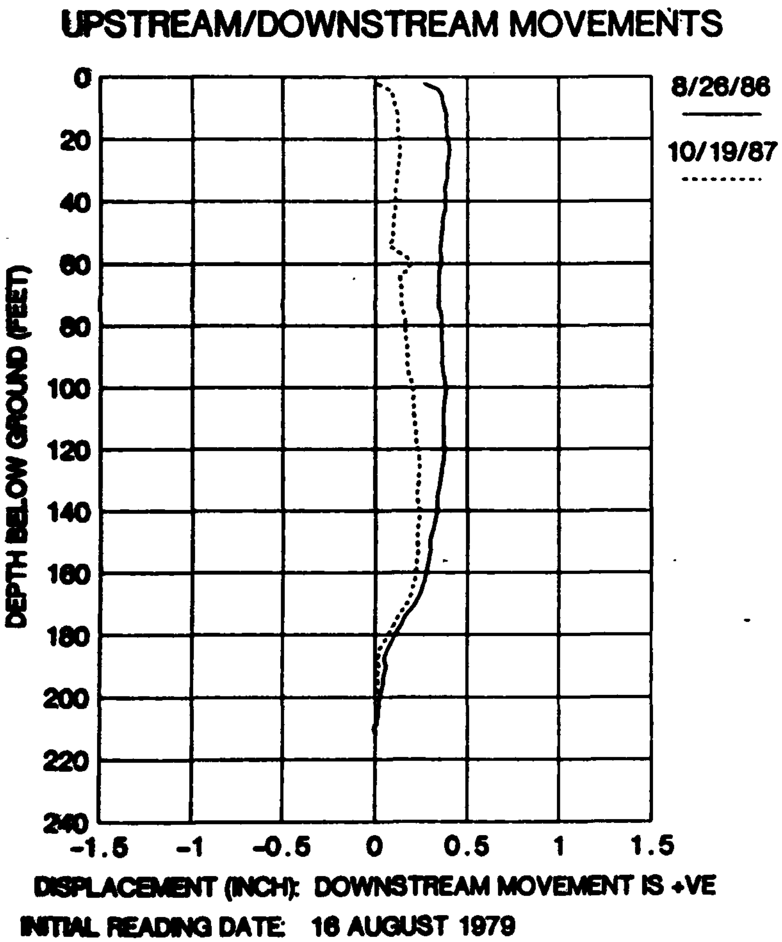
DISPLACEMENT (INCH): RIGHT BANK MOVEMENT IS +VE

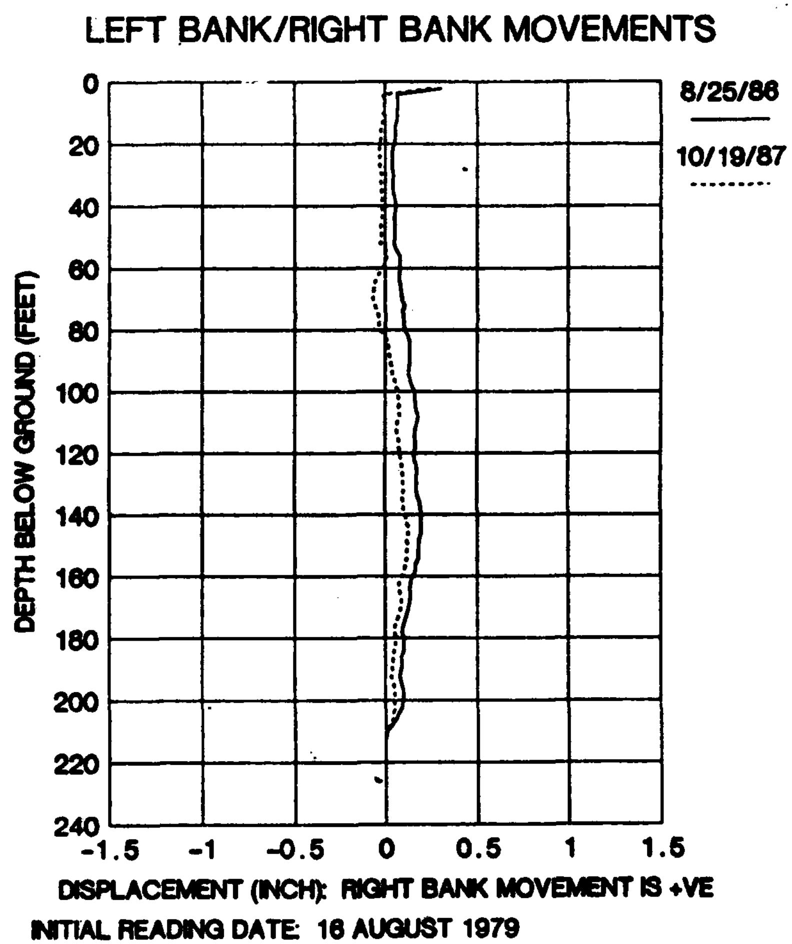
INITIAL READING DATE: 15 AUGUST 1979

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-12





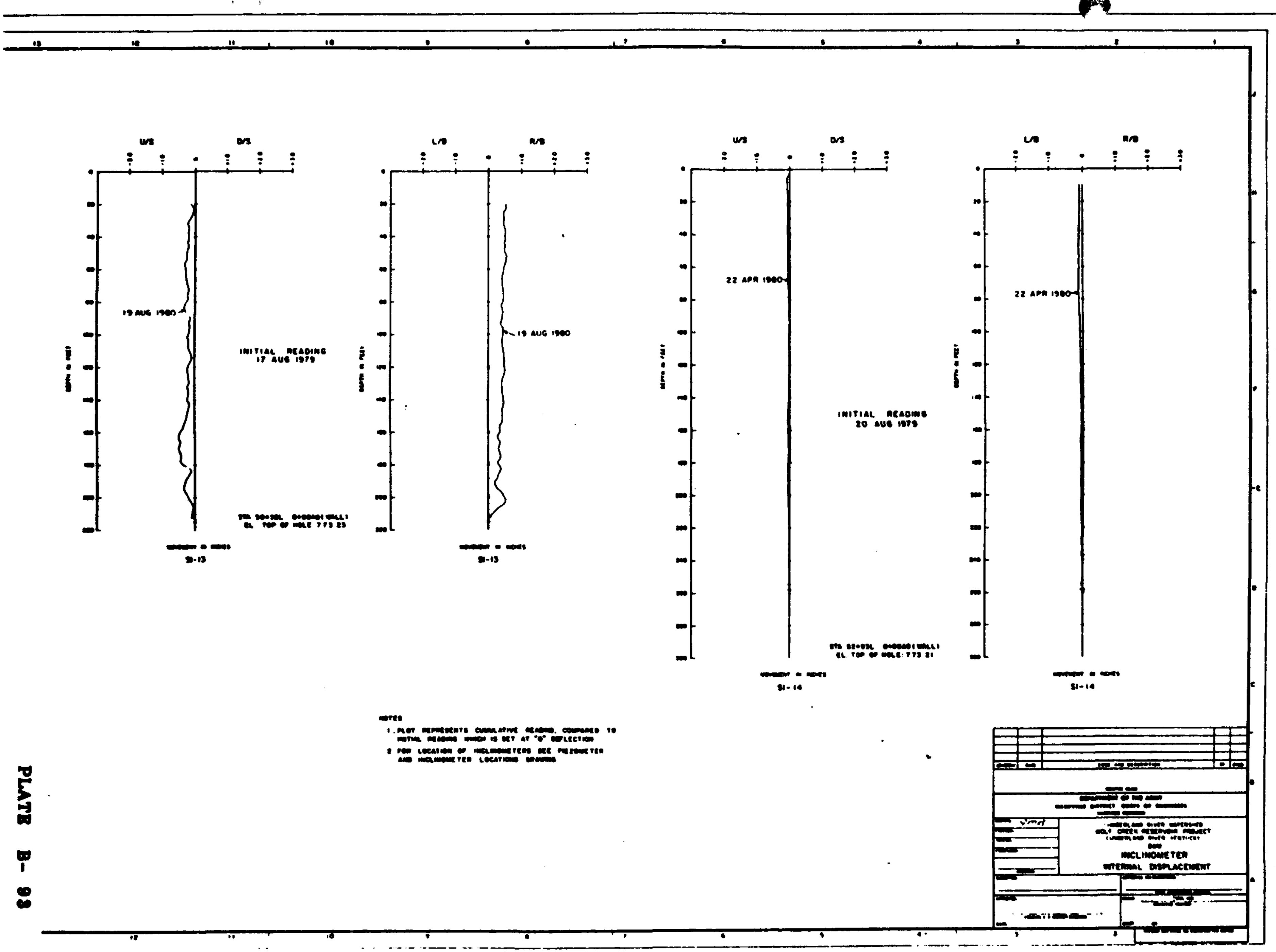
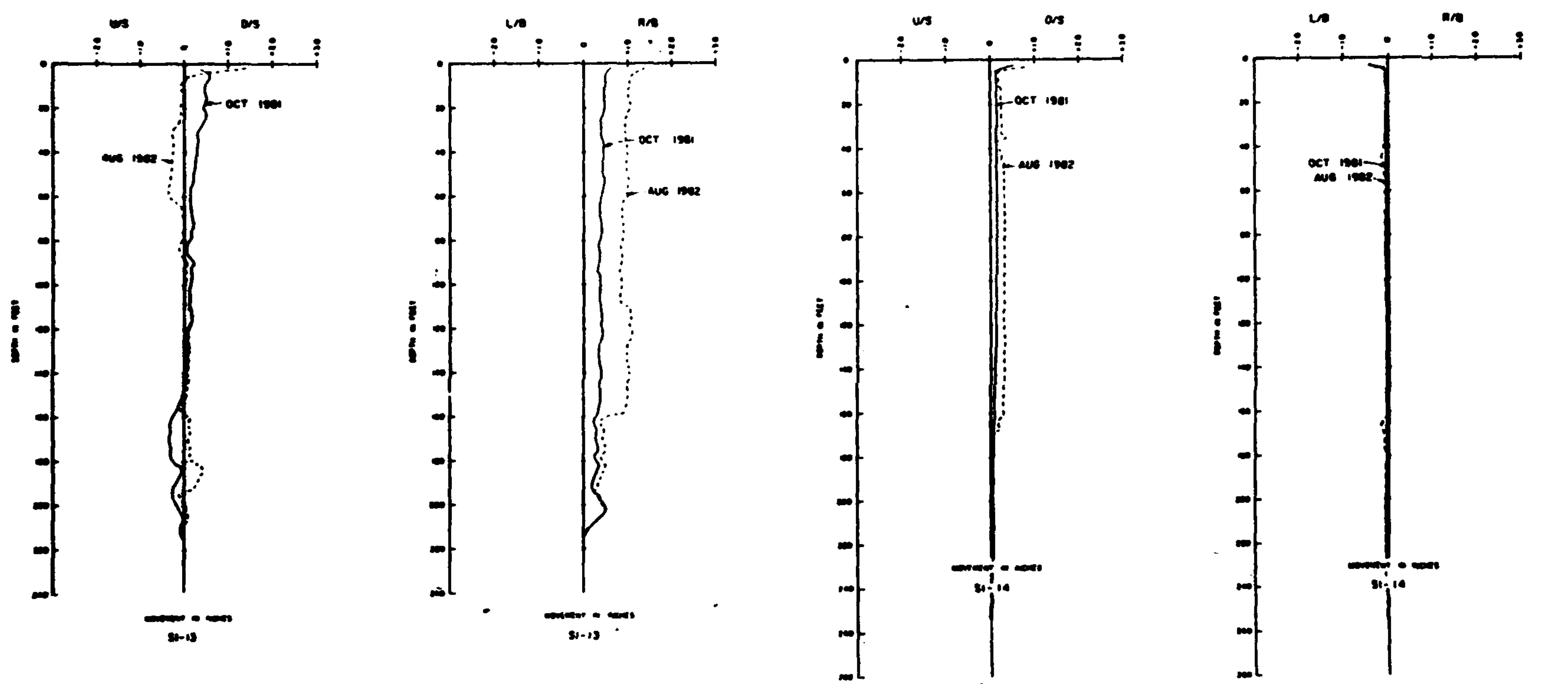
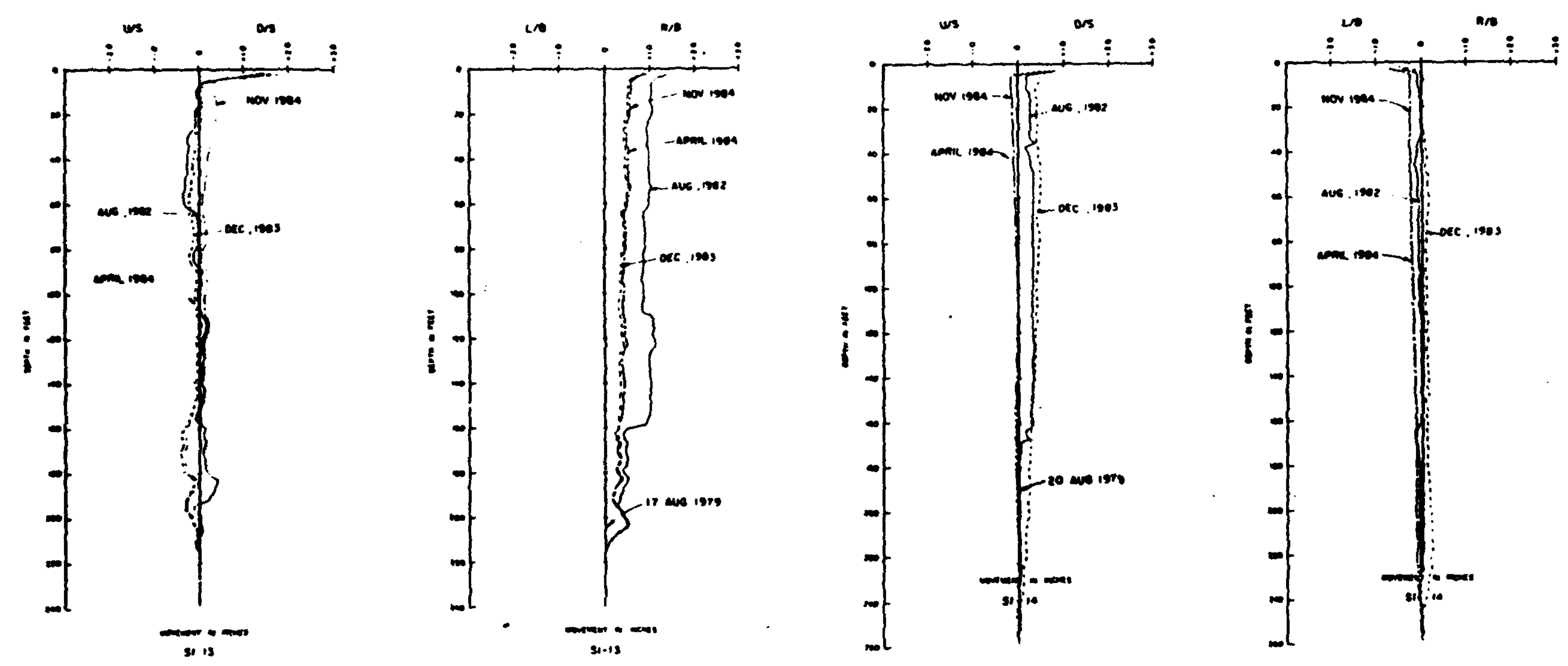

U/S
D/S
L/B
R/B
DEPTH IN FEET
19 AUG 1980
INITIAL READING
17 AUG 1979
STA 50+95L
EL. TOP OF HOLE 773.23
MOVEMENT IN INCHES
SI-13
22 APR 1980
INITIAL READING
20 AUG 1979
STA 52+95L
EL. TOP OF HOLE 773.21
SI-14
NOTES
1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION
2 FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING
DEPARTMENT OF THE ARMY
WOLF CREEK RESERVOIR PROJECT
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 93



INCLINOMETER
INTERNAL DISPLACEMENT

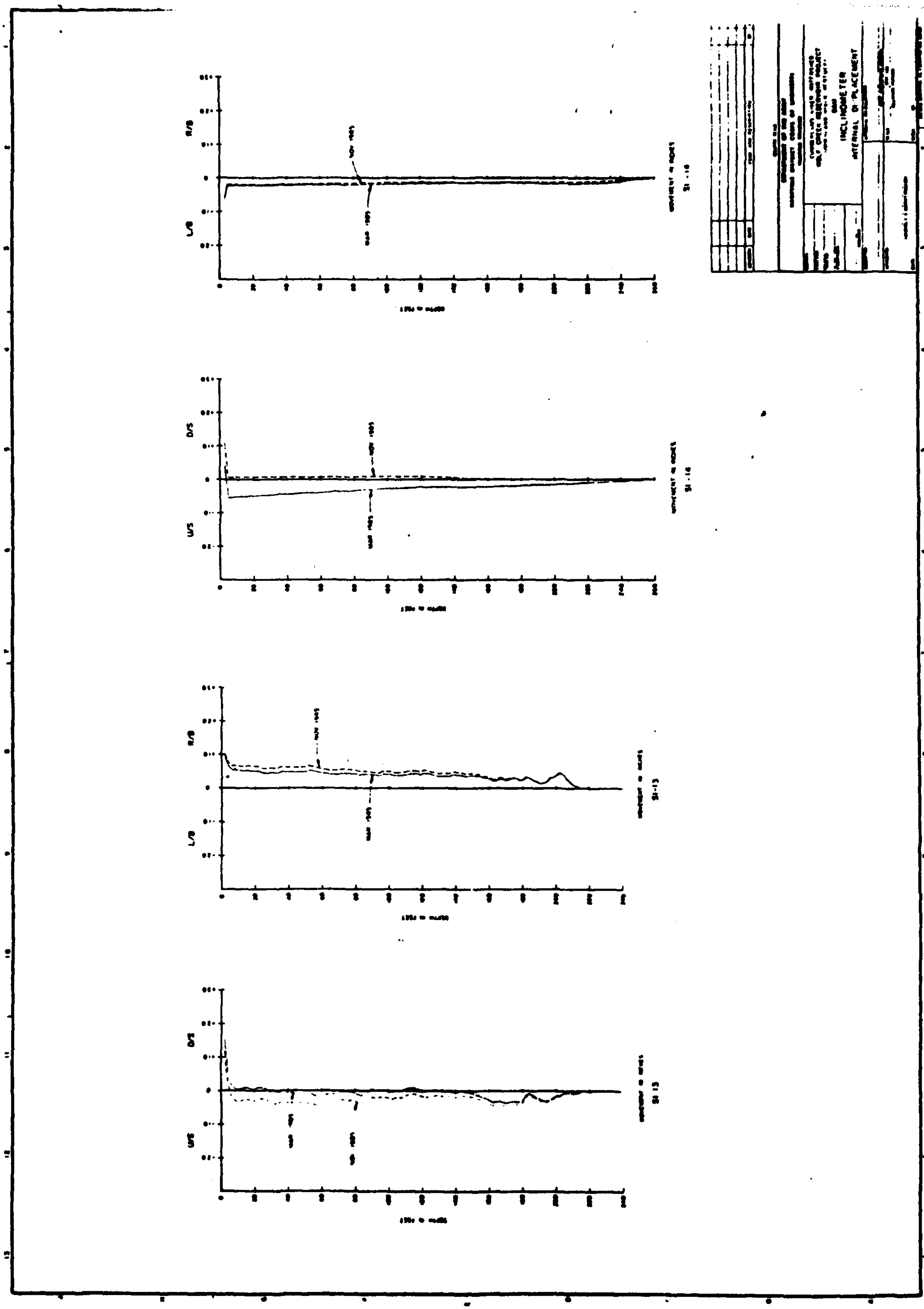
PLATE B- 94



WOLF CREEK RESERVOIR PROJECT

INCLINOMETER CASING
INTERNAL DISPLACEMENT

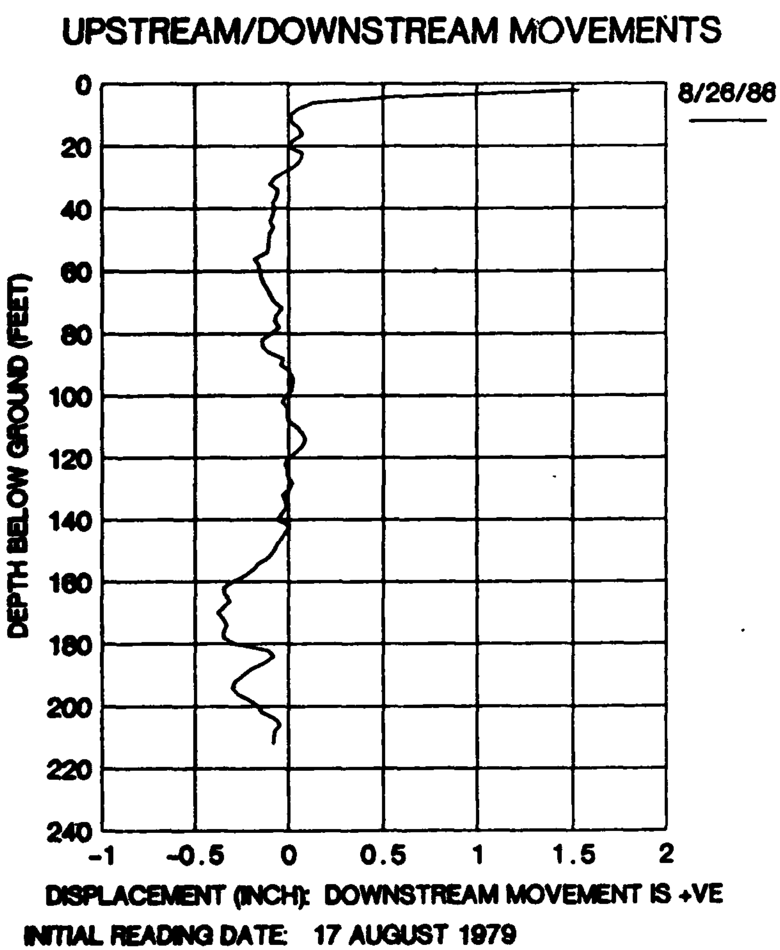
PLATE B- 95

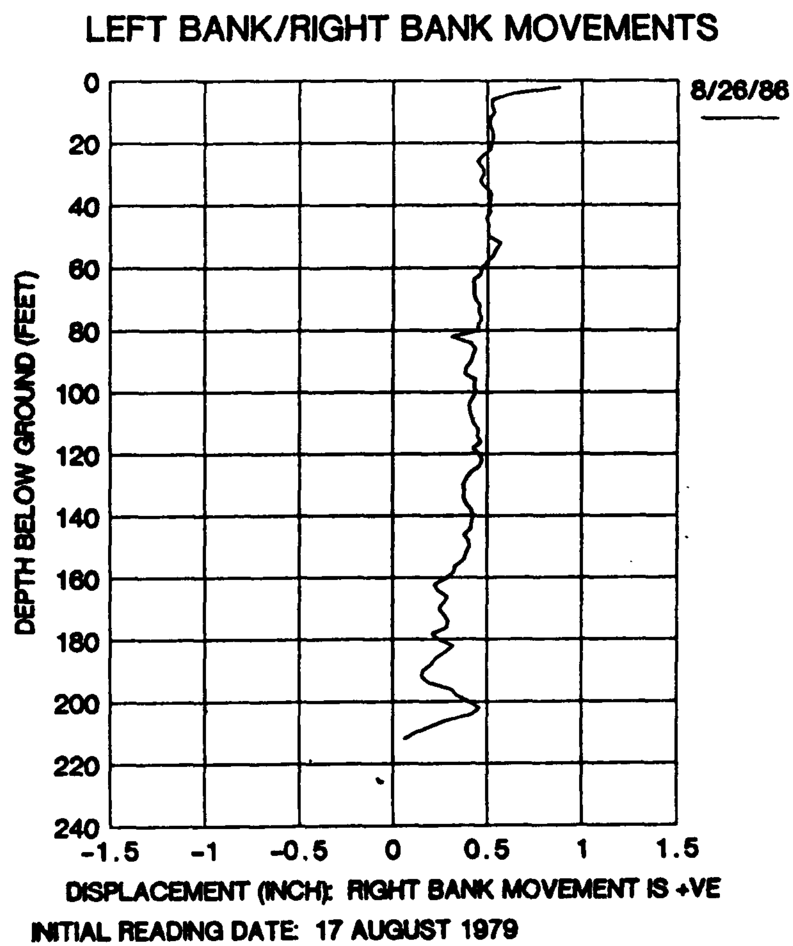

INCLINOMETER
INTERNAL DISPLACEMENT

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-13



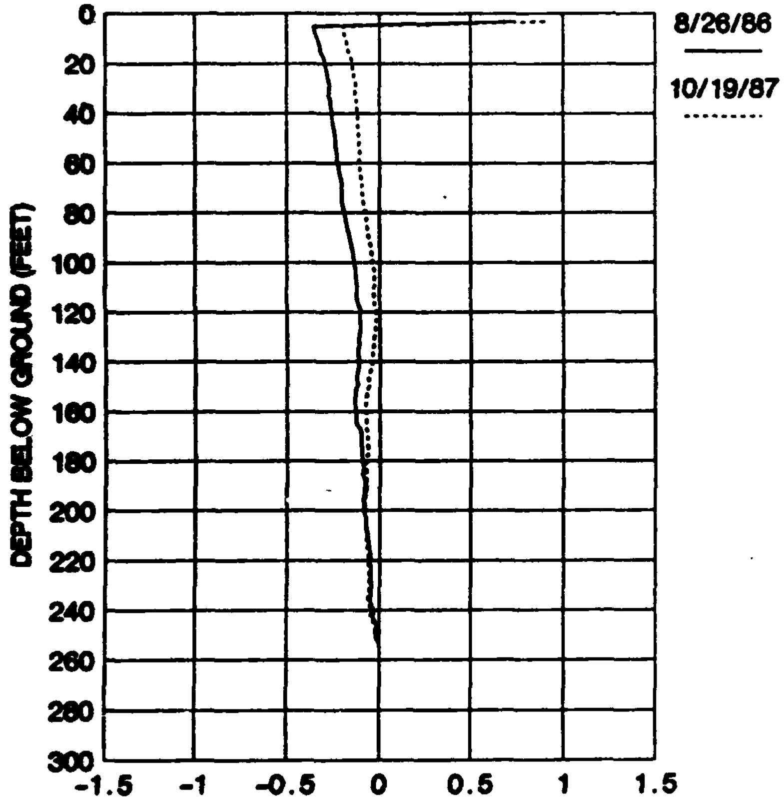


WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-14

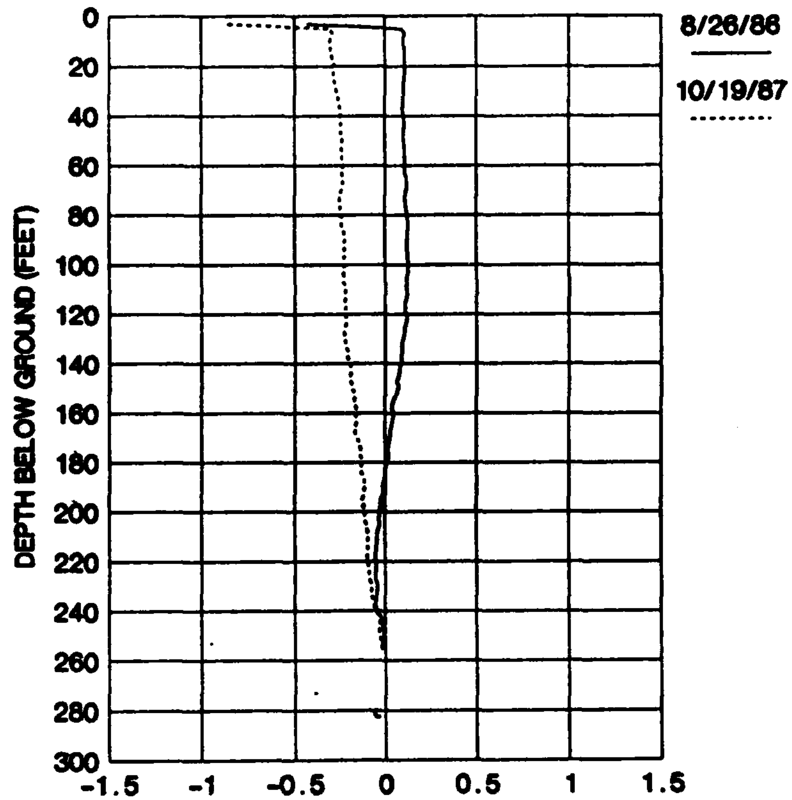
UPSTREAM/DOWNSTREAM MOVEMENTS



DISPLACEMENT (INCH): DOWNSTREAM MOVEMENT IS +VE

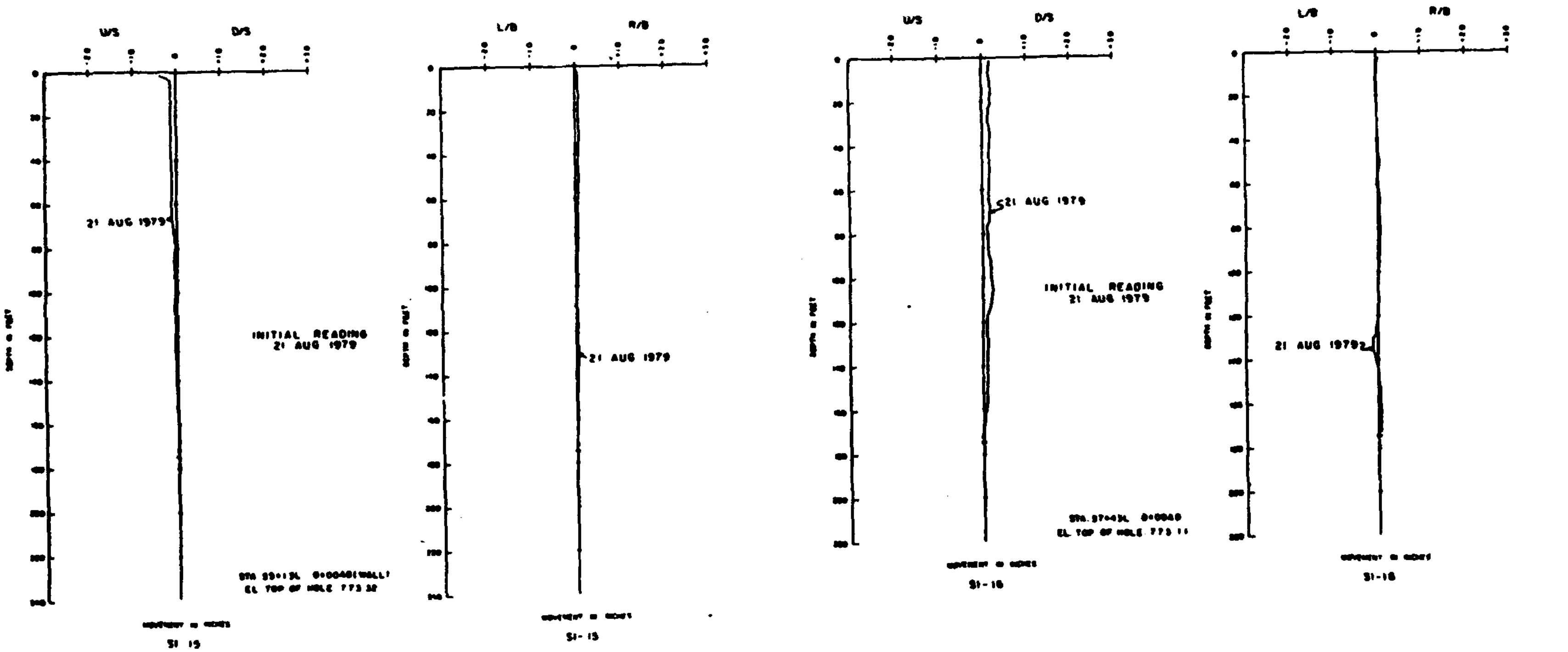
INITIAL READING DATE: 20 AUGUST 1979

LEFT BANK/RIGHT BANK MOVEMENTS



DISPLACEMENT (INCH): RIGHT BANK MOVEMENT IS +VE

INITIAL READING DATE: 20 AUGUST 1979



NOTES

1. PLOT REPRESENTS CUMULATIVE READING, COMPARED TO INITIAL READING WHICH IS SET AT "0" DEFLECTION.
2. FOR LOCATION OF INCLINOMETERS SEE PIEZOMETER AND INCLINOMETER LOCATIONS DRAWING.

DEPARTMENT OF THE ARMY

WOLF CREEK RESERVOIR PROJECT

DAM

INCLINOMETER

INTERNAL DISPLACEMENT

PLATE B- 99

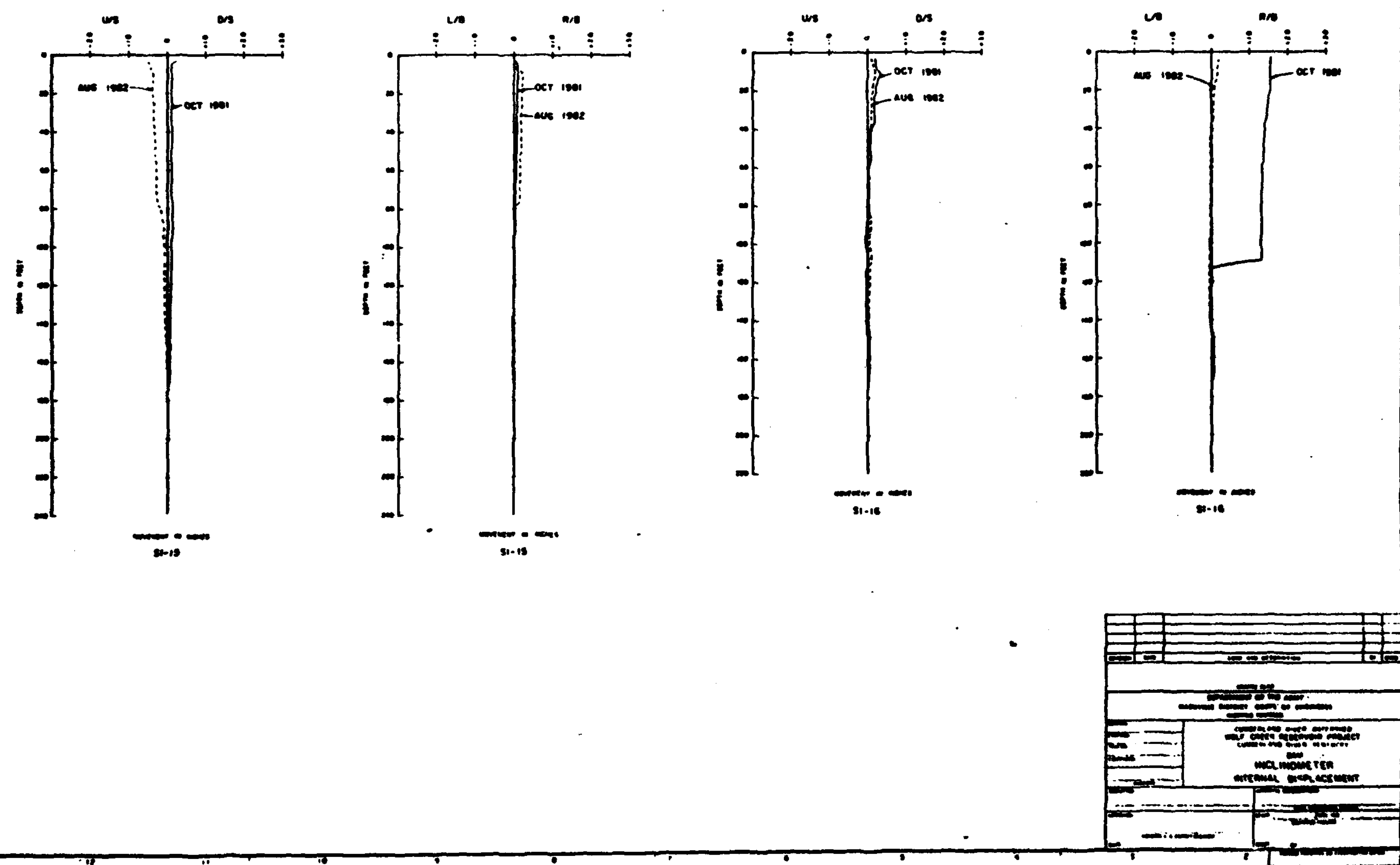

U/S
D/S
AUG 1982
OCT 1981
SI-19
L/B
R/B
OCT 1981
AUG 1982
SI-15
U/S
D/S
OCT 1981
AUG 1982
SI-16
L/B
R/B
AUG 1982
OCT 1981
SI-16
WOLF CREEK RESERVOIR PROJECT
INCLINOMETER
INTERNAL DISPLACEMENT

PLATE B- 100

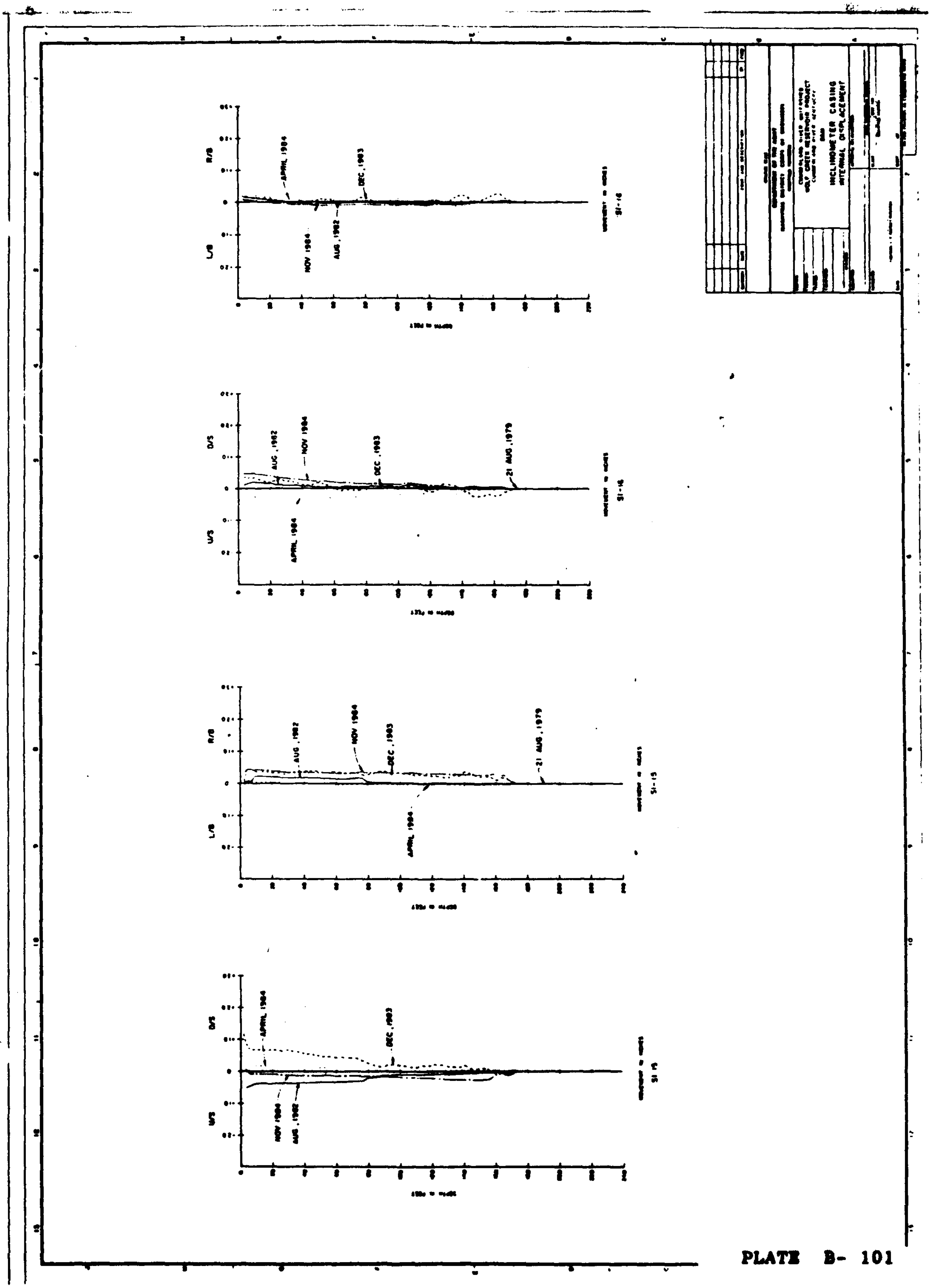

INCLINOMETER CASING
INTERNAL DISPLACEMENT
WOLF CREEK RESERVOIR PROJECT
R/B
L/B
D/S
U/S
APRIL 1984
NOV 1984
AUG. 1982
DEC. 1983
21 AUG. 1979
SI-16
SI-15
MOVEMENT IN INCHES
DEPTH IN FEET

PLATE B- 101

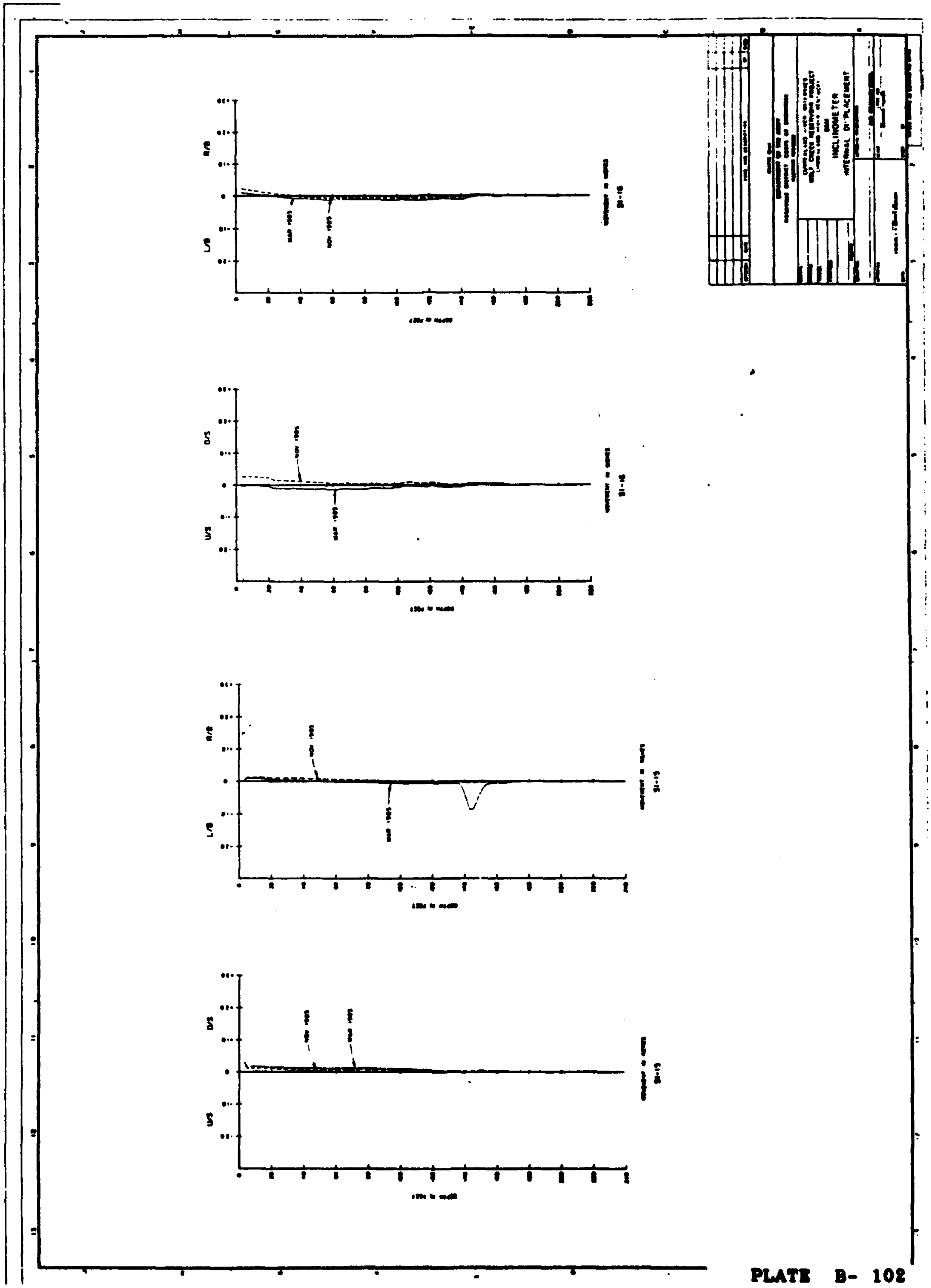
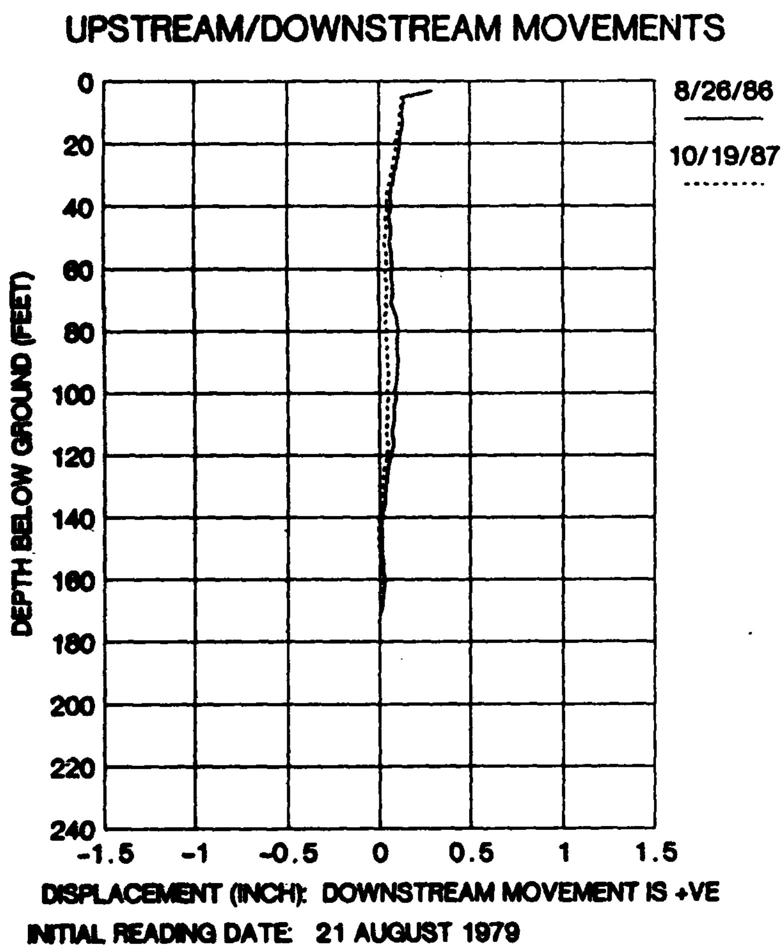


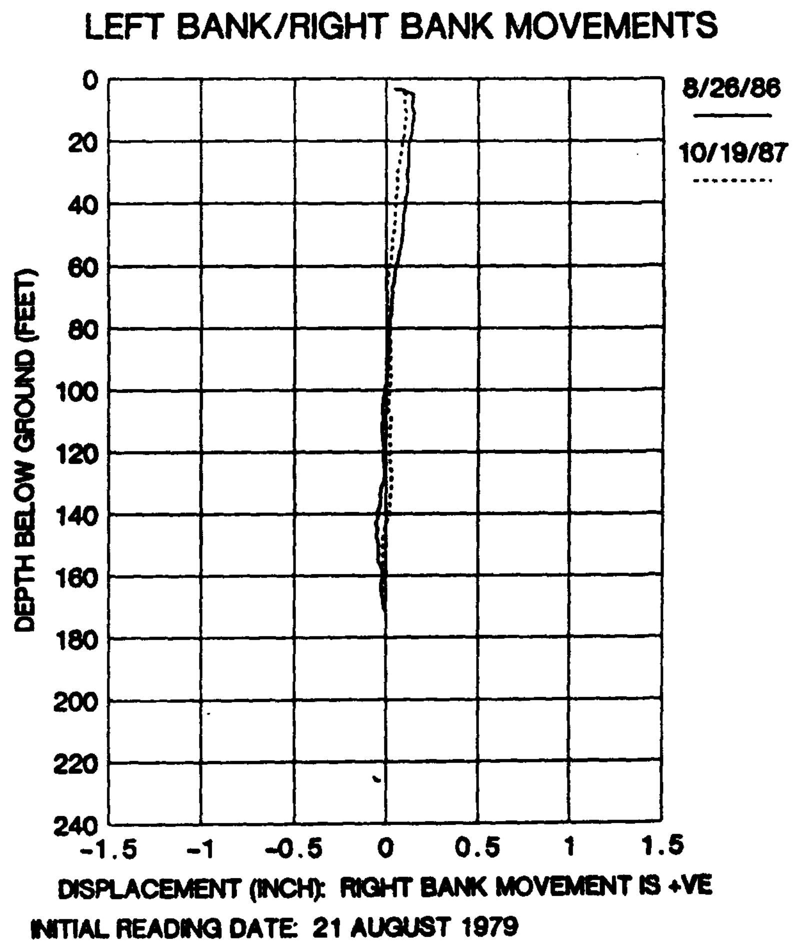
PLATE B- 102

WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-15

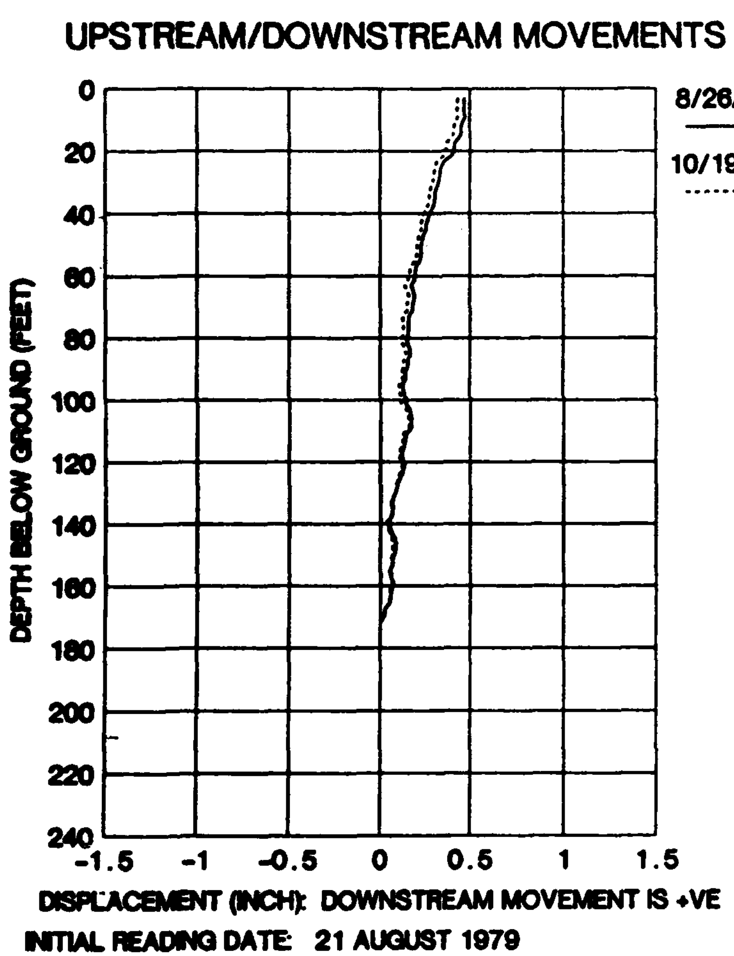


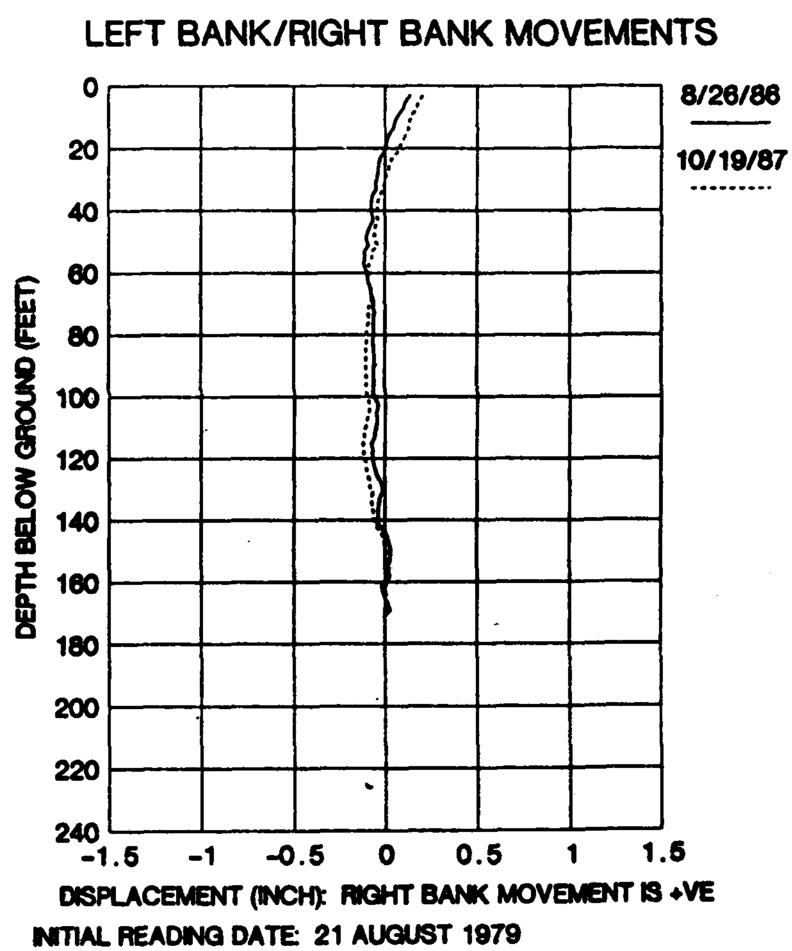


WOLF CREEK DAM, JAMESTOWN, KENTUCKY

LATERAL MOVEMENT DATA

INCLINOMETER SI-16





APPENDIX C

SAMPLE CONSTRUCTION FORMS

DESCRIPTION OF FORMS

The following forms were made a part of the permanent construction record:

PAGES C-1 thru C-12.	Engineering Form 1836 used for both primary and secondary excavation.
PAGE C-13.	Unofficial form recording plan of final verticality for primary elements.
PAGE C-14.	Unofficial form recording sections of final verticality for primary elements.
PAGE C-15.	ORN form 507-A (One Time) recording pressure test results for the NQ test borings.
PAGE C-16.	ORN form 507-D (One Time) recording pressure grout and backfill results for the NQ test borings.
PAGE C-17.	Unofficial computation sheet to determine relative distance between adjacent primary elements used in secondary verticality measurements.
PAGE C-18.	Unofficial computation sheet comparing actual secondary measurements with the theoretical.
PAGE C-19.	ORN Form 507-C (One Time) recording concrete placement data.
PAGE C-20.	Unofficial form recording mud level readings.
PAGE C-21.	Engineering Form 1836 recording detailed summary of each primary element.

Hole No. P-3B3

DRILLING LOG	DIVISION ORD	INSTALLATION NASHVILLE DISTRICT	SHEET 1 OF 12 SHEETS

1. PROJECT WOLF CREEK DAM	10. SIZE AND TYPE OF BIT AS SHOWN
2. LOCATION (Coordinates or Station) 41+42.80 L-AXIS	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY ICOS-DRILLERS KY LTD-GEOTEK.	12. MANUFACTURER'S DESIGNATION OF DRILL AS SHOWN
4. HOLE NO. (As shown on drawing title and file number) P-3B3	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED 6 — UNDISTURBED NONE
5. NAME OF DRILLER VARIOUS	14. TOTAL NUMBER CORE BOXES 3
6. DIRECTION OF HOLE [x] VERTICAL [ ] INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER N/D
	16. DATE HOLE — STARTED 6/20/77 — COMPLETED 7 JULY 77
7. THICKNESS OF OVERBURDEN 180.3	17. ELEVATION TOP OF HOLE 772.50
8. DEPTH DRILLED INTO ROCK 77.2	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE 257.5	19. SIGNATURE OF INSPECTOR GB Nelson

ELEVATION	DEPTH	LEGEND	CLASSIFICATION OF MATERIALS (Description)	% CORE RECOVERY	BOX OR SAMPLE NO.	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant)
772.50	0.0		TOP OF ¢ GUIDEWALL			
			OPEN			1st Shift 6-20-77
770.5	2.0					Start clamming @ 1400 hrs. using 53" Clam
	5.0		CLAY, silty, stiff, r-b. w/ ASG. (FILL)			CONSTRUCTION OF CONCRETE DIAPHRAGM WALL Contract No. DACW62-75-C-0206
	10.0					
	15.0					
	20.0					
	25.0					
	30.0					
	35.0					
	40.0					End Shift 1730 6-20-77 / Begin Shift 1730 6-20-77
	45.0					
722.50	50.0					

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT) — PROJECT WOLF CREEK DAM — HOLE NO. P-3B3

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION Nashville District	SHEET 2 of 12 SHEETS

1. PROJECT Wolf Creek Dam
2. LOCATION (Coordinates or Station) 71+42.80 L-Axis
3. DRILLING AGENCY
4. HOLE NO. (As shown on drawing title and file number) P-383
5. NAME OF DRILLER
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED 6/16/77 | COMPLETED
17. ELEVATION TOP OF HOLE 772.50
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR Kearns

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
722.50	50.0		CLAY, brown, moist damp, stiff (FILL)			
	55.0					
	60.0				#1 60.0	
	65.0					Shaved Hole at 65.'
	70.0					
	75.0					+79.5' 4⅞" csg. +20.4⅞" csg. 99.8 Move off hole 0100 6-21-77 1st Shift on 6-22-77 Start conveyor @ 0900 hrs Change to 40-Clam
	80.0					
	85.0					
	90.0				#C 92'	Unit @ 95' 0.075 Rim 0.09 D1
	95.0					End Shift Begin Shift 0730 6-23-77 +10' csg. Ttl. 109.8' 1730-1830 Down for repairs.
672.50	100.0					

76'

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Wolf Creek Dam | HOLE NO. P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NED	SHEET 3 OF 12 SHEETS

1. PROJECT Wolf Creek Dam	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) 4+42.8 D L	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY ICOS	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) P-383	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	16. DATE HOLE: STARTED / COMPLETED
	17. ELEVATION TOP OF HOLE 772.5
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
672.5	100.0		CLAY, silty, brown, stiff, moist, damp. (FILL)			
	105.0				#3 106.0	Vert. 104' 0.065 DS, 0.035 LW. -30' 132 csg., TH. 119.7 Mud 105', 63.5, 29.8, 7.0, tr.
						End Shift 1330 6-23-77 / 1st Shift 0?00 6-25-77 — 109'
	110.0					
	115.0					
	120.0					
						Vert. @ 125' 0.25 load 0.05 DS +19.9 Csg, TH: 139.6'
	125.0					
						End Shift @ 128' / Begin Shift 1730 6-23-77
	130.0					
						+10' 4?" csg., TH. 149.6'
	135.0				#4 135.0	Mud 136', 64.0, 29.2, 6.5, tr.
	140.0					-10' 4?" csg., TH. 139.6' Vert. 142', 0.04 DS, 0.115 LW. Move off hole 0200 6-2?-77 / 1st Shift 0?00 6-2?-77
						+81.0' + 80.0' Csg 4" ø TH: 161.0' change to 3?" diam.
	145.0					
					#5 148	Mud Test @ 150' 63, 29, 9.5, Trace
622.5	150.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Wolf Creek Dam | HOLE NO. P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NED	SHEET 4 OF 12 SHEETS

1. PROJECT Wolf Creek Dam	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) 41+42.80 C, A/S	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY ICW	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) P383	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE 772.5
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
622.5	150.0					
			CLAY, silty, stiff, moist (ALLUVIUM?)			V.t. @ 156 0.005 D/S 0.140 Lond +10.1 Csg, TH 171.1
	155.0					
	160.0					End Shift 1730 Begin Shift 1730 6-27-77
608.6	164.0					Vert 164; 64.5, 300, 8.0, 0.025%
	165.0		Sand, wet, brown loose (ALLUVIUM)		#6 166.0	Vert. 165, 0.005 D/S, 0.165 Lwd. -10.1'+19.9' csg., TH 180.9
						End Shift 0330 6-27-77 16' Begin Shift 0730 6/27/77
	170.0					
						End Shift @ 1730 6/27/77 174
	175.0					Begin Shift 1730 6/27/77 +10.1 csg TH 191.0
						Vert @ 180.3' 0.04 D/S 0.125 Lwd -10.1 csg TH 180.9
592.2	180.0 / 180.9		TOR @ 0030 6-28-77			
			SEE SHEET # 5			
	185.0					
	190.0					
	195.0					
572.5	200.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Wolf Creek Dam — HOLE NO. P-383

No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NASHVILLE DISTRICT	SHEET 3 OF 12 SHEETS

1. PROJECT: WOLF CREEK DAM
2. LOCATION (Coordinates or Station): 41+42, BO L-AXIS
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): P-383
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT: 56"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Hughes 820
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE: 772.30
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
593.30	180.0					
592.2	180.3		TOP OF ROCK 180.30 @ 0030 6/28/87			0.0 1/2/3 - 0.125 LAND
	181.0		LIMESTONE, WEATHERED W/TRACES OF GROUT & CLAY MIXED W/LIMESTONE, MED GRAY TO DK GRAY			BEGIN DRILLING @ 0920 6/28/87 TOOLS 200.0 TABLE 12.0 PSI 70 RPM 32 ROTARY 600 BIT FORCE 10 TO 15,000 MUD LEVEL 1.0 OUT 1.4 IN
590.5	182.0		LIMESTONE, MED HD f-XLN, W/ARGIL TO SHY ZONES MED. GRAY TO DK GRAY			
	183.0					
	184.0					
	185.0					
	186.0					
	187.0					
	188.0					CHECK TOTCO @ 188'- 1/8° ADD 10 SCREW = 210.0 MUD LEVEL 3.0 IN & OUT
	189.0					
582.50	190.0					

ENG FORM MAR 71 1836 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: WOLF CREEK DAM | HOLE NO.: P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NASHVILLE DISTRICT	SHEET 6 OF 12 SHEETS

1. PROJECT WOLF CREEK DAM	10. SIZE AND TYPE OF BIT 36"
2. LOCATION (Coordinates or Station) 41+42.80 L-Axis	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL HUGHES B20
4. HOLE NO. (As shown on drawing title and file number) P 383	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED / UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☒ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
7. THICKNESS OF OVERBURDEN	16. DATE HOLE — STARTED / COMPLETED
8. DEPTH DRILLED INTO ROCK	17. ELEVATION TOP OF HOLE 772.50
9. TOTAL DEPTH OF HOLE	18. TOTAL CORE RECOVERY FOR BORING %
	19. SIGNATURE OF INSPECTOR [signature]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
582.50	190.0					
582.3	190.2		LIMESTONE, Med. bd. f-xln, w/Argil. To Sh'y Zones MED-GRAY TO DK GRAY			
	191.0					TOOLS 210.0 TABLE 12.0 PSI 80 RPM 34 ROTARY 1500 BIT FORCE 25 TO 30,000 MUD LEVEL 3.0 in feet
	192.0					
	193.0		→ GROUT & CLAY FILLED CAVITY w/SOME WEATHERED LIMESTONE			
	194.0					
	195.0					
	196.0					MUD TEST @ 196' 66.0, 29.0, 11+, 0.25%
576.1	196.4					
	197.0					
	198.0					CHECK TOTCO @ 198': 3/8° ADD 10' STEM 220.0 MUD LEVEL 2.6 in feet
	199.0					
572.50	200.0					[illegible]

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT WOLF CREEK DAM | HOLE NO. P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NASHVILLE DISTRICT	SHEET 7 OF 12 SHEETS

1. PROJECT WOLF CREEK DAM	10. SIZE AND TYPE OF BIT 36"
2. LOCATION (Coordinates or Station) 41+47.60 ¢-Axis	11. DATUM FOR ELEVATION SHOWN (TBM or MSL) MSL
3. DRILLING AGENCY	12. MANUFACTURER'S DESIGNATION OF DRILL HUGHES 820
4. HOLE NO. (As shown on drawing title and file number) P-383	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
6. DIRECTION OF HOLE ☑ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.	15. ELEVATION GROUND WATER
	16. DATE HOLE — STARTED — COMPLETED
7. THICKNESS OF OVERBURDEN	17. ELEVATION TOP OF HOLE 772.50
8. DEPTH DRILLED INTO ROCK	18. TOTAL CORE RECOVERY FOR BORING %
9. TOTAL DEPTH OF HOLE	19. SIGNATURE OF INSPECTOR Edward Wright / [illegible]

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
572.50	200.0		Limestone, mottled med-dk gr, f xln mss bdd, w/ num foss.			
	201.0					
	202.0					202.4 @ 1820 mud level - 2.6 in, 2.2 out 30,000 psi BiT, 70 AiR
	203.0					
	204.0					
	205.0					205.0' @ 1930 mud test 65.8, 69.2, 8, 0.25
	206.0					
	207.0		few pieces of GROUT			207.0 @ 2100 Totco - 1/4°, 1/4° Audrid - 230.0' — mud @ 4.5' in, 4.0 out
	208.0					
	209.0					
562.50	210.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT WOLF CREEK DAM

HOLE NO. P-383

Hole No. P-383

DRILLING LOG | DIVISION: ORD | INSTALLATION: Nashville District | SHEET 8 of 12 SHEETS

1. PROJECT: Wolf Creek Dam
2. LOCATION (Coordinates or Station): 41+42, 80 L-Axis
3. DRILLING AGENCY:
4. HOLE NO. (As shown on drawing title and file number): P-383
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☒ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT: 36"
11. DATUM FOR ELEVATION SHOWN (TBM or MSL): MSL
12. MANUFACTURER'S DESIGNATION OF DRILL: Hughes Bro
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE: 772.50
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Edward Wright

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
563.50	210.0		Limestone mottled med gr w/few lt gr argil sh interbdd. - foss, xln.			
	211.0					
	212.0					
559.5	213.0		BOH for 36" ∅	213.0	213.0	0005 - 29 June 77
559.3	213.2		Top of Core @ 213.0' Frags from bot. of Hole. Limestone mottled med gr, fine xln, foss, w/interbdd sh			Begin 1100, 6.29.77
558.5	214.0		Bkn on sh ptg			Pull 1, Tools 222.1, Begin 1230, End 1250, DT 20 min, Run 3.1, Rec 2.9, Loss 0.2, DA Smooth, DWR 100%
557.4	215.0 / 215.1		Bkn on sh ptg	100 %		
557.3	215.2		Bkn on sh ptg			
556.6	215.9 / 216.0		Bkn by drl			CD = 215.9
				216.1		bot P.1 216.1
556.3	216.2		Bkn on sh ptg			Pull 2, Tools 232.1, Begin 1255, End 1320, DT 25 min, Run 10.0, Rec 10.0, DWR 100%, DA Smooth
555.9	216.6		Bkn by drl			
555.5	217.0		Spin on sh ptg		Box #1	
555.0	217.5		Bkn on sh ptg	100 %		
554.7	217.8		Bkn on sh ptg			
	218.0					
	219.0					
553.2	219.3		Spin on lt argil pl			
552.50	219.9 / 220.0		Spin on ls argil pl			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Wolf Creek Dam | HOLE NO. P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NED	SHEET 9 OF / 2 SHEETS

1. PROJECT: Wolf CREEK DAM
2. LOCATION (Coordinates or Station): 41+42.80 L-AXIS
3. DRILLING AGENCY: Geotek
4. HOLE NO. (As shown on drawing title and file number): P-383
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT: NQ
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED / UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE: STARTED / COMPLETED
17. ELEVATION TOP OF HOLE: 772.5
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR: Edwitt Wright

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
552.5	220.0		Limestone, mottled, ocdgr, f-fn, fos, w/shld sh			
552.1	220.4		Bk-bydd			
551.8	220.7		Bk-on sh pty			
551.4	221.0 / 221.1		Sp-on sh bddg pl			
550.4	222.0 / 222.1		Sparry calcite filled vugs			
550.2	222.3					
550.1	222.4		Sp-on sh pty			
550.0	222.5		Spin on sh pty			
549.3	223.0 / 223.2		spin on sh pty			
549.0	223.5		Spin on sh pty			
548.4	224.0 / 224.1		Bk-bydd			
548.2	224.3		Spin on sh bddg pl			
547.8	224.7		Spin on LS bddg pl			
	225.0					
547.0	225.5		Spin on sh pty		Box # 1	
546.6	225.9 / 226.0		Bk-bydd			CD = 225.9
				226.1		Bit P-2 226.1
	227.0					Pull 3 Tools 242.1 Begin 1325 End 1355 DT 30min Run 10.0 Rec 9.8 Loss 0.2 DA Smooth Dwl 100%
545.2	227.3		Bk-on sh pty			
544.8	227.7		Bk-bydd		227.7	
544.6	227.9 / 228.0		Bk-on sh pty	100 %		
543.7	228.8		Spin on sh pty		Box # 2	
	229.0					
543.0	229.5		Spid			
542.5	229.9		Clay shale			
542.5	230.0					

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Wolf CREEK DAM | HOLE NO. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NED	SHEET 10 OF 12 SHEETS

1. PROJECT: Wolf CREEK DAM
2. LOCATION (Coordinates or Station): 41+42.80 L-AXIS
3. DRILLING AGENCY: Geotek
4. HOLE NO. (As shown on drawing title and file number):
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ____ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT: NQ
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE: 772.5
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Everett Wright

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
542.5	230.0		Limestone med bl, med gr, Sdm, fos/uf-f Wsm			
542.1	230.4		Bkn on Sh ptg			
541.6	230.9		Spl on sh ptg			
	231.0					
541.0	231.5		Spin on Sh ptg			
540.9	231.6		Bkn on Sh ptg			
540.5	232.0		Bkn on Sh ptg			
540.1	232.4		Bkn on Sh ptg .05' calcite vugg			
	233.0					
	234.0				Box # 2	
	235.0					
539.4	235.1		.05' calcite vug			
539.2	235.3		Bkn by drl			
			⅓ of core grout + ⅔ LS (old core hole)			
536.8	235.7		Bkn by drl			CD = 235.7
	236.0			236.1		Est P-3 236.1
536.2	236.3		Spin			Pull 4 Tools 252.1 Begin 1400 End 1425 DT 25 min Run 9.8 Rec 10.2 Grind DA Smooth BWR 100%
	237.0		LS w/grout			
534.8	237.7		Spin on Sh ptg	100 %		
	238.0					
534.2	238.3		Bkn by drl			
533.8	238.7		Bkn by drl			
	239.0					
533.4	239.1		Spin on Sh ptg			
533.3	239.2		Calcite vugg			
532.9	239.6		Spin on Sh ptg			
532.5	240.0		Bkn on Sh ptg			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: Wolf CREEK DAM | HOLE NO. P-383

Hole No. P-383

DRILLING LOG	DIVISION ORD	INSTALLATION NED	SHEET 11 OF 12 SHEETS

1. PROJECT Wolf CREEK DAM
2. LOCATION (Coordinates or Station) 41+42.80 L-Axis
3. DRILLING AGENCY Geotek
4. HOLE NO. (As shown on drawing title and file number)
5. NAME OF DRILLER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN
8. DEPTH DRILLED INTO ROCK
9. TOTAL DEPTH OF HOLE
10. SIZE AND TYPE OF BIT NQ
11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
12. MANUFACTURER'S DESIGNATION OF DRILL
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN | DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES
15. ELEVATION GROUND WATER
16. DATE HOLE | STARTED | COMPLETED
17. ELEVATION TOP OF HOLE 772.5
18. TOTAL CORE RECOVERY FOR BORING %
19. SIGNATURE OF INSPECTOR Elliott Wright

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
532.5	240.0		Limestone, mottled, med gy, f xln, fos, w/ interbedded sh			
531.6	240.9		Bk on sh ptg			
	241.0				Box # 2	
	242.0					
530.2	242.3		Bk by drl			
529.8	242.9		Spin on sh ptg		242.9 Box # 3	
529.4	243.0 243.1		Spin on sh ptg			
529.0	243.5		Bk on sh ptg			
528.8	243.7		Spin on sh ptg			
528.4	244.0 244.1		spin on sh ptg			
	245.0					
527.2	245.3		Bk on sh wvy pl			
526.6	245.9		Bk by drl	245.9		Bot P-4 245.9 = CD
	246.0					
526.3	246.2		Bk by drl			Pull 5
526.1	246.4		Bk by drl			Tools 262.1
525.8	246.7		Bk on sh ptg			Begin 1455
	247.0					End 1525 DT 30 min Run 10.1 Rec 10.1
524.4	248.0 248.1		Spin on sh ptg	100 %		
523.9	248.6		Bk on sh ptg			
	249.0					
523.0	249.5		Bk on sh ptg			
	249.8		Bk on sh ptg			
522.5	250.0		Bk by drl			

ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT Wolf CREEK DAM | HOLE NO. P-383

Hole No. P-383

DRILLING LOG | DIVISION: ORD | INSTALLATION: NED | SHEET 12 OF 12 SHEETS

1. PROJECT: Wolf CREEK DAM
2. LOCATION (Coordinates or Station): 41 + 42.80 L-AXIS
3. DRILLING AGENCY: Geotek
4. HOLE NO. (As shown on drawing title and file number):
5. NAME OF DRILLER:
6. DIRECTION OF HOLE: ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.
7. THICKNESS OF OVERBURDEN:
8. DEPTH DRILLED INTO ROCK:
9. TOTAL DEPTH OF HOLE:
10. SIZE AND TYPE OF BIT: NQ
11. DATUM FOR ELEVATION SHOWN (TBM or MSL):
12. MANUFACTURER'S DESIGNATION OF DRILL:
13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN: DISTURBED | UNDISTURBED
14. TOTAL NUMBER CORE BOXES:
15. ELEVATION GROUND WATER:
16. DATE HOLE: STARTED | COMPLETED
17. ELEVATION TOP OF HOLE: 772.5
18. TOTAL CORE RECOVERY FOR BORING: %
19. SIGNATURE OF INSPECTOR: Edward Wright

ELEVATION (a)	DEPTH (b)	LEGEND (c)	CLASSIFICATION OF MATERIALS (Description) (d)	% CORE RECOVERY (e)	BOX OR SAMPLE NO. (f)	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) (g)
522.5	250.0		Limestone, med bd, med gy, f-l-m, w/ cl bdsl, fos			
522.3	250.2		Bkn by drl			
521.8	250.7		Bkn on sh ptg			
	251.0					
521.2	251.3		Bkn on sh ptg			
	252.0					
520.3	252.2		Bkn on sh ptg			
519.5	253.0		Bkn on sh ptg			
519.1	253.4		Bkn on sh ptg		Box #3	
518.9	253.6		Bkn on sh ptg			
518.7	253.8		Bkn by drl			
	254.0					
518.3	254.2		Bkn on sh ptg			
518.2	254.3	Sh	Bkn on sh ptg			
	255.0					
516.8	255.7		Sp on ch ptg			
516.5	256.0		Bkn by drl	256.0		Bot P-5 256.0 = CD
				100 %		Pull 6 Tools 272.1 Begin 1515 End 1530 DT 15 min Run 1.5 Rec 1.5
	257.0					
515.3	257.2		Bkn on sh ptg			
515.0	257.5		TD @ 257.5 6/29/77	257.5	257.5	DA smooth DWR 100%
	258.0					Drilling Completed 29 Jul 77
	259.0					CONSTRUCTION OF CONCRETE DIAPHRAGM WALL Contract No. DACW62-75-C-0206
512.5	260.0					

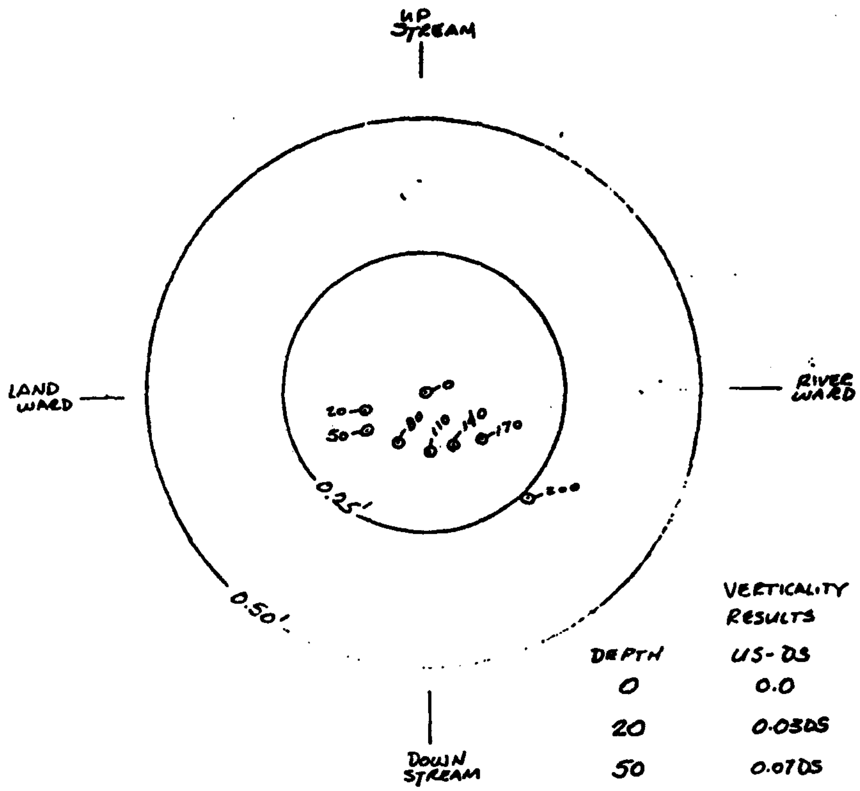
ENG FORM 1836 MAR 71 PREVIOUS EDITIONS ARE OBSOLETE. (TRANSLUCENT)

PROJECT: WOLF CREEK DAM | HOLE NO. P-383

13 Dec 76 CED

Verticality Deviations in Primary Element P-399

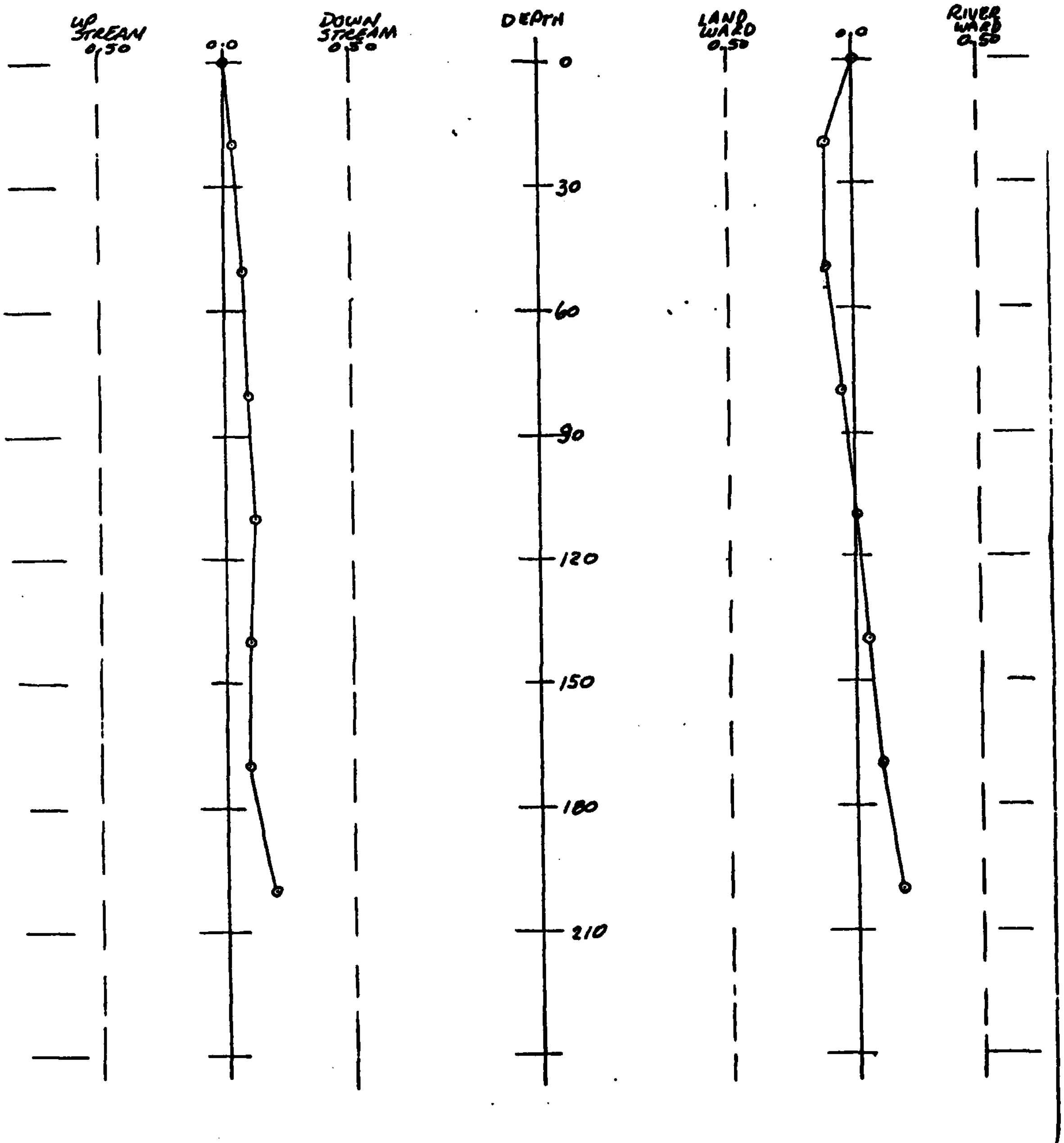
Sheet 1 of 2
DACW 62-75-C-0206



VERTICALITY RESULTS

DEPTH	US-DS	LW-RW
0	0.0	0.0
20	0.03DS	0.105LW
50	0.07DS	0.105LW
80	0.09DS	0.05LW
110	0.11DS	0.005RW
140	0.095DS	0.05RW
170	0.085DS	0.10RW
200	0.19DS	0.18RW

13 Dec 76 Verticality Deviations in Sheet 2 of 2
CED Primary Element P-399 DACW 62-75-C-0206



PRESSURE TEST

SHIFT 0700-1730

HOLE NO. P-383 DATE: 6/30/77 WEATHER: clear + Hot

DEPTH		GAGE PRESSURE POUNDS PER SQUARE INCH	METER READINGS CFS		TOTAL CFS	TIME		EXTENT OF TEST MINUTES	LEAKAGE CFS PER MINUTE
From	To		Beginning of Test	End of Test		Beginning of Test	End of Test		
247.5	257.5	50	2094.6	2094.6	0	0740	0745	5	0
237.5	257.5	50	2094.7	2094.7	0	0748	0753	5	0
227.5	257.5	50	2095.0	2095.0	0	0755	0800	5	0
214.0	257.5	50	2095.2	2095.2	0	0805	0810	5	0

EQUIPMENT:

DESCRIPTION	NO.	WORK	IDLE	DOWN
Core Drill	1	1		

PERSONNEL

TYPE EMPLOYEE	NO.	HOURS
Operator	1	1
Oiler	1	1
Laborer	1	1

[signature] INSPECTOR

GROUTING

SHIFT: 0700-1730

HOLE NO. P-383 DATE: 6/30/77 WEATHER: clear + Hot

Time	Mix		Water	Cement	Sand		Total Solids	
Start 0820	W 3	Batch	3	1	—		1	No take
	C 1	Total in Hole	0	0	—		0	
Stop 0840	S	Bottom Ins. Pipe 214.0	Pressure 20	Water Level	Additives			

Time	Mix		Water	Cement	Sand		Total Solids	
Start 0850	W 1	Batch	3	3			3	Mixed 3 Bags Cement
	C 1	Total in Hole	2	2			2	Placed 3 cf grout = 2 Bags Cement
Stop 0855	S	Bottom Ins. Pipe 257.0 235.0	Pressure	Water Level	Additives			

Time	Mix		Water	Cement	Sand		Total Solids	
Start	W	Batch						
	C	Total in Hole						
Stop	S	Bottom Ins. Pipe	Pressure	Water Level	Additives			

Time	Mix		Water	Cement	Sand		Total Solids	
Start	W	Batch						
	C	Total in Hole						
Stop	S	Bottom Ins. Pipe	Pressure	Water Level	Additives			

EQUIPMENT:

DESCRIPTION	NO.	WORK	IDLE	DOWN
Grout Plant	1	2		
Core drill	1	2		

PERSONNEL

TYPE EMPLOYEE	NO.	HOURS
Operator	1	2
Oiler	1	2
Laborer	1	2

REMARKS: Pulled Packer 10' above Rock & flushed w/H2O

Bags Cement Mixed = 3
Cf Grout Placed = 2
Connections = 2

ORN Form 507-D (One Time)
May 1976

ORNCD

Elliott Wright
INSPECTOR

CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	PAGE 1 OF 1 PAGES
		DATE 4 MAY 77
INSTALLATION ORNCD-WOL	SUBJECT DISTANCE BETWEEN PRIMARY ELEMENTS FOR	
COMPUTED BY CED	COMPUTATION SECONDARY ELEMENT # S-136	NUMBER 75-C-0206
CHECKED BY –		

DISPLACEMENTS: A = U/S − D/S + (0.0); B = L/W − R/W + (4.50)

DISTANCE $D = (\sqrt{A^2 + B^2}) - 2.17$

DEPTH	VERTICALITY RDGS. P-137 U/S	VERTICALITY RDGS. P-135 U/S	DISPLACEMENTS		DISTANCE
0	0.02; 0.08	0.0; 0.0	A	0.02	
			B	4.42	D = 2.25′
20	0.16; 0.02	0.045; 0.18	A	0.115	
			B	4.56	D = 2.39′
50	0.195; 0.08	0.08; 0.18	A	0.115	
			B	4.76	D = 2.59′
80	0.21; 0.18	0.095; 0.355	A	0.115	
			B	4.935	D = 2.77′
110	0.375; 0.225	0.165; 0.305	A	0.21	
			B	5.03	D = 2.86′
140	0.305; 0.285	0.125; 0.15	A	0.18	
			B	4.935	D = 2.77′
170	0.255; 0.30	0.10; 0.11	A	0.155	
			B	4.91	D = 2.74′
200	0.21; 0.275	0.195; 0.16	A	0.015	
			B	4.935	D = 2.77′
230	0.225; 0.31	0.12; 0.115	A	0.105	
			B	4.925	D = 2.76′
260	0.185; 0.35	0.10; 0.135	A	0.085	
			B	4.885	D = 2.72′
___			A	___	
			B	___	D =

* – INDICATES INTERPOLATED POINTS.

CORPS OF ENGINEERS, U.S. ARMY OHIO RIVER DIVISION	COMPUTATION SHEET	PAGE 1 OF 1 PAGES
INSTALLATION ORNCD-WOL	SUBJECT COMPARISON OF "VERTICALITY MEASUREMENTS" FOR SECONDARY ELEMENT.	DATE
COMPUTED BY		NUMBER 75-C-0206.
CHECKED BY		

DEPTH	MEASURED DISTANCE P-137 to P-135 (M)	CALCULATED DISTANCE P-137 to P-135 (C)	DIFFERENCE (M - C)
0	2.25	2.25	0.00
20	2.38	2.39	-0.01
50	2.42	2.59	-0.17
80	2.65	2.77	-0.12
110	2.85	2.86	-0.01
140	2.75	2.77	-0.02
170	2.71	2.74	-0.03
210	2.69	2.77	-0.08
230	2.71	2.76	-0.05
260	2.63	2.72	-0.09

* Indicates interpolated point.

A difference of -0.875' is necessary to allow the chisel to stop tracking the primary casings.

HOLE NO. P-385 DATE: 16 Dec 1976 WEATHER: Partly Cloudy & Cool

INSTALL TREMIE		CONCRETE		DEPTH		VOLUME CONCRETE	WASTE	BATCH NO.	SLUMP	AIR
START	FINISH	START	FINISH	BOTTOM OF TREMIE	TOP OF CONCRETE					
1230	1345	1400	-	212	175	8	-	1	7½"	6¾%
			-	195	165	-	-	-	-	-
			1427	175	164	-	-	-	-	-
		1430	-	175	142	8	-	2	-	-
			1445	155	105	-	-	-	-	-
		1455	1505	115	50	8	-	3	-	-
		1515	-	75	15	8	-	4	-	-
			1545	15	8					
		1605	1615	15	-	1	*-	5	-	-

TIME LOST

REMARKS:

* Approximately 4 Yds. Wasted In Grout.

33 Yds. Delivered To Job.

Batch No.	Conc. Temp.
1	49°
2	50°
3	52°
4	49°

EQUIPMENT:

DESCRIPTION	NO.	WORK	IDLE	DOWN
4" Mud Wheel Pump	1	1		
Ready Mix Truck (H.C.)	2	1-3 Hrs 1-2½ Hrs		

PERSONNEL

TYPE EMPLOYEE	NO.	HOURS
Concrete Specialist	1	4
Laborer	2	8
Pump Operator	1	2
Teamster (H.C.)	2	1-3 Hrs 1-2½ Hrs

REMARKS: Stop Placement of 1st Batch @ 1410. Remove 17' of Tremie Pipe. Resume Placement @ 1415. Stop @ 1420. Remove 20' of Tremie Pipe. Resume @ 1425. Finish @ 1427.
Stop Placement of 2nd Batch @ 1435. Remove 20' of Tremie Pipe. Resume Placement @ 1440. Finish @ 1445.
Stop Placement of 4th Batch @ 1520. Remove 60' of Tremie Pipe. Resume Placement @ 1535. Finish @ 1545.
Remove Remaining Tremie Pipe and Equipment and Move Off Hole @ 1630

ORN Form 507-C (One Time)
May 1976

ORNCD

Ric Pearce
INSPECTOR

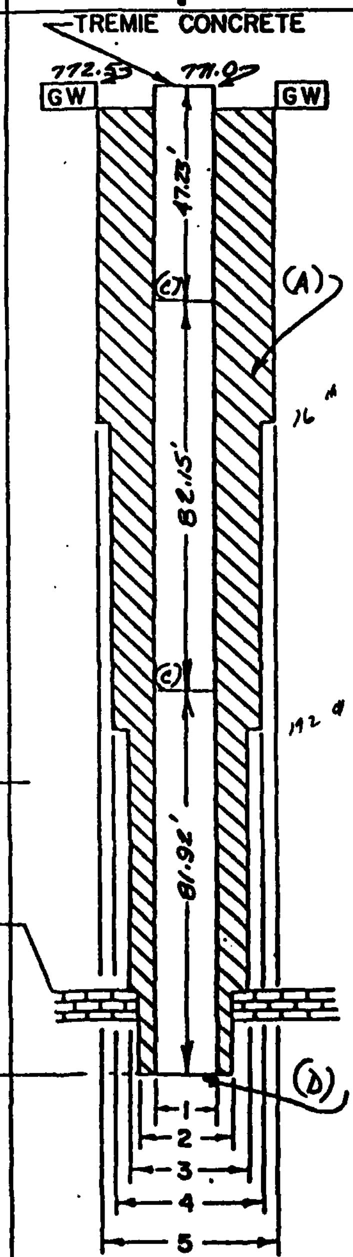
MUD LEVELS
HOLE NO. 393 #1 of 2

DATE	TIME	DEPTH			REMARKS	
		HOLE	INSIDE CASING	OUTSIDE CASING		
22 Apr	1630	181.6	5.0	3.6	inside estimated, prob.	accurate to 0.5'
"	1700	182.6	5.0	4.0	during reverse air r	otary rock drilling.
"	1740	184.1	5.0	4.0	[illegible] @ 184.1, wtr	draining from trench sa.
"	1805	184.6	5.0	5.8	Desander clogged, broke	circ., last 20-30
"	1910	186.8	8.0	9.5	got of straight [illegible] Drop from Loss to de	min. started circ. sander.
"	2005	187.4	5.4	10.0	Some wtr from washer	running into ann. spc.
"	2045	189.2	5.0	5.5	2130 added mud (U.) t	o hole to bring up [illegible]
"	2120	193.5	4.0	4.3	Mud gelled from cla	y in cavern, broke circ.
"	2225	195.0	4.3	5.0	filled inside of drl str. w	/H2O, got circ. back @ 22
23 APRIL	0200	200.0	7.0	6.0	RUNNING SMOOTHLY AF	TER PASSING CAVITY.
"	0400	202.5	7.0	5.2	SMALL AMOUNT of MUD ADDED	TO [illegible] THAT USED
"	0500	205.73	9.5	8.0	CUTTING BOX FROM SANDRA	IS HOLDING LARGE volume [illegible]
"	0730	207.57	7.0	6.4	SOME MUD ADDED TO H	OLE (5.3 [illegible])
"	0820	207.63	9.0	8.4	ALSO NOTE - pumped DESA	NDER READING -
"	0845	215.47	12.4	11.4	WITH TOOLS CIRCULAT	ING - LAST READING.
23 April	1600	212.50	18.7	19.2	TOOLS REMOVED FROM HOLE	
"	1710	212.50	20.0	20.5		
"	2100	212.50	22.0	22.0		
24 Apr	0330	212.5	27.0	23.0		
"	0730	212.5	29.0	23.0		
	1300	212.5	32.2	22.6		
	1400	"	32.8	22.6		
	1500	"	33.4	22.6		
24 April	1730	212.5	34.8	22.6		
	1830	212.5	35.3	22.6		
	1930	212.5	35.9	22.6		
	2030	212.5	36.5	22.6		
25 Apr	0930	212.5	41.5	22.6		
"	1030	"	41.9	22.6		
	1130	"	42.3	22.7		
	[illegible]		42.6	22.7		
	1330	"	42.9	23.2		
	1430	"	42.4	24.6		
	1530	"	39.2	28.6		
	1630	"	35.7	31.0		
	1700	"	35.7	31.6		
	1800		34.8	32.8		
	1900		34.6	33.3		
	2000		34.6	33.6		
26 April	0030		36.6	36.0		
	0200		37.4	38.5		
	0300		37.8	38.5		
	0400		38.3	33.5		
	0500		38.8	33.6		

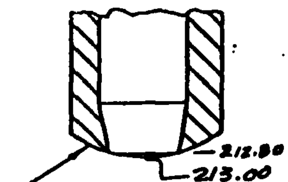
DRILLING LOG	ORD	INSTALLATION NASHVI…E DISTRI…	SHEET / OF / SHEETS

1. PROJECT WOLF CREEK DAM	10. SIZE AND TYPE OF BIT
2. LOCATION (Coordinates or Station) STA. 41+42.80L ON AXIS	11. DATUM FOR ELEVATION SHOWN (TBM or MSL)
3. DRILLING AGENCY ICOS	12. MANUFACTURER'S DESIGNATION OF DRILL
4. HOLE NO. (As shown on drawing title and file number) P-383	13. TOTAL NO. OF OVER-BURDEN SAMPLES TAKEN — DISTURBED — UNDISTURBED
5. NAME OF DRILLER	14. TOTAL NUMBER CORE BOXES
	15. ELEVATION GROUND WATER
6. DIRECTION OF HOLE ☐ VERTICAL ☐ INCLINED ______ DEG. FROM VERT.	16. DATE HOLE — STARTED 20 JUNE 77 — COMPLETED 7 JULY 77
	17. ELEVATION TOP OF HOLE AS SHOWN
7. THICKNESS OF OVERBURDEN	18. TOTAL CORE RECOVERY FOR BORING %
8. DEPTH DRILLED INTO ROCK	19. SIGNATURE OF INSPECTOR C E Hodson 18 Aug 77
9. TOTAL DEPTH OF HOLE	

ELEVATION a	DEPTH b	LEGEND c	CLASSIFICATION OF MATERIALS (Description) d	% CORE RECOVERY e	BOX OR SAMPLE NO. f	REMARKS (Drilling time, water loss, depth of weathering, etc., if significant) g
772.5	0.0		TREMIE CONCRETE			CONSTRUCTION OF CONCRETE DIAPHRAGM WALL, DACW 62-75-C-0206
	30.0					(A) ANNULAR SPACE FILLING MIX (GROUT). (B) GRAVEL FILTER BLANKET. (Not Encountered) (C) FIELD WELDS. (D) DETAIL OF BOTTOM. (NOT TO SCALE)
	60.0	EMBANKMENT				TREMIE CONCRETE: 29½ Cu. Yd. on 7-July 77
	90.0					
	120.0					
±622.5	150.0	? ALLUVIAL OB				
592.2	180.0 / 180.3					
559.5	210.0 / 213.0	LIMESTONE				



* cavity 190.2 - 196.1



CURVED BOTTOM CUT BY 36" ROCK BIT.

LEGEND:

GW- GUIDEWALL

(1) 26" O.D. PERMANENT CASING.

(2) 36" DIAMETER HOLE IN ROCK.

(3) HOLE CUT BY 41¼" TEMPORARY CASING.

(4) HOLE CUT BY 47" TEMPORARY CASING.

(5) 52" OPEN HOLE.

ENG FORM 1836 PREVIOUS EDITIONS ARE OBSOLETE. | PROJECT WOLF CREEK DAM | HOLE NO. P-383

APPENDIX D

CONCRETE PROBLEMS

APPENDIX D
CONCRETE PROBLEMS

Provisions were made in the bid schedule to test core concrete in completed elements to check the quality of the tremie concrete. Of the 700 elements in the Phase I contract, including the switchyard, 49 were test cored. Of the 556 elements in the Phase II contract, 26 were cored.

Zones of substandard concrete consisting of segregated materials, uncemented aggregates, and various degrees of honeycombing, were encountered from the outset and steps were taken to alter procedures to remedy the problem. These problems were isolated in the primary elements.The discrepancies logged in the secondaries were usually of a minor nature or could be explained by the bit temporarily leaving the element in annular space grout on uneven side walls.

For a detailed analysis of suspected causes and tests conducted at the project, see Holland and Turner, Construction of Tremie Concrete Cutoff Wall, Wolf Creek Dam, Kentucky. This report will be limited to listing the changes in procedures used in attempt to correct the problem and summarizing the results found from the test borings.

Numerous corrective actions were taken throughout the contracts to help improve the concrete quality. The first action was to delay the placement a minimum of 10 days between the placement of annular space grout and tremie concrete and circulate cool water in the permanent casing. It was felt that the heat of hydration of the annular space grout was raising the temperature in the casing sufficiently to cause a flash set.

The following are other changes instituted in the Phase I contract:

1. Changed the retrievable traveling plug from a basketball to a 9.63 in. pine sphere.
2. Limited the height of the tremie pipe off the bottom of the hole to 0.3 ft. for the first 30 seconds of placement.
3. Insured good seal on tremie pipe joints by heavy usage of grease on threads, tightening while hammering, and numbering sections to keep same order of string.
4. Limited rate of concrete rise in element to maximum of 8 feet per minute.
5. Limited tremie removal rate to maximum of 0.3 feet per second.
6. Limited slump range to 6.5 to 7.5 inches from the original 6 to 8 inches.
7. Limited maximum embedment of tremie pipe in concrete to 60 feet.

Most of the above changes were instituted in April of 1977.

During the Phase II contract centering fins were added to the tremie pipe; and, arguably the most effective change, in April of 1978 a retarder was added to the mix design.

Four elements experienced a loss of seal during placement. After coring the second to lose its seal - P-303, and finding substantial segregation, procedures were changed from the specified reinsertion of a dry pipe and continuing placement to termination of placement, allowing placed concrete to set, recleaning the element and only then

continuation of tremie concrete.

Table D-1 lists all elements in which the concrete was cored, Phase I followed by Phase II, primaries followed by secondaries. Individual sections are in order of date concrete placed. Core depths and element depths are compared (it was difficult to remain within the element through the entire depth). The remarks section indicates whether the concrete was determined to be sound, describes minor problems encountered, or refers to Table D-2 if major problems were present or if further investigations or remedial actions were made. Segregation near the top of hole (indicative of initial concrete mixing) above reservoir level may be omitted.

Table D-2 contains narratives of those problems described as significant in Table D-1.

TABLE D-1

CONCRETE ELEMENTS TEST CORED

PHASE I
PRIMARY ELEMENTS
PLACED USING BASKETBALL

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
P-451	22 APR 76	11 NOV-2 DEC 77	213.2	212.6	Hit Casing	SIGNIFICANT PROBLEMS
P-417	30 APR 76	2 MAR- 4 MAR 77	213.4	156.4	Hit Casing	Badly Honeycombed 61.2 to 64.0 and 152.0 to 156.4
P-473	6 MAY 76	14 NOV- 17 NOV 77	214.5	213.3	Hit Casing	SIGNIFICANT PROBLEMS
P-541	14 MAY 76	4 MAR- 8 MAR 77	213.0	212.1	Hit Casing	SIGNIFICANT PROBLEMS
P-509	17 MAY 76	17NOV-23 NOV 77	213.1	212.5	Hit Casing	SIGNIFICANT PROBLEMS
P-397	27 MAY 76	2 DEC- 12 DEC 77	213.8	89.4	Hit Casing	Badly Honeycombed 37.3 to 39.0 Moderately Honeycombed 46.0 to 48.9
P-395	14 JUL 76	25 FEB- 1 MAR 77	213.3	212.8	Hit Casing	Sandy Grout 131.5 to 132.0 and 132.2 to 133.2
P-251	18 AUG 76	15 DEC- 19 DEC 77	213.8	212.8	Hit Casing	SIGNIFICANT PROBLEMS
P-203	17 SEP 76	4 JAN- 5 JAN 78	239.2	129.0	Hit Casing	Widely Scattered Honeycombing
P-507	29 SEP 76	24 FEB- 25 FEB 77	213.1	134.5	Hit Casing	SIGNIFICANT PROBLEMS
P-163	13 OCT 76	16 FEB- 21 FEB 77	278.3	233.3	Hit Casing	U.L. 52.9 to 53.0, Sand Washed Out in Drill Water. 1/2 Core Washed Out as Sand in Drill Water 105.4 to 106.1
P-179	14 OCT 76	2 NOV- 11 NOV 77	278.2	277.6	Bit and Reamer Twisted Off	SIGNIFICANT PROBLEMS
P-457	14 NOV 76	12 DEC- 15 DEC 77	213.2	177.8	Hit Casing	Bad to Moderate Honeycombing Throughout. No Appreciable Loss of Core
P-109	9 DEC 76	14 FEB- 17 FEB 77	278.4	278.4/ 282.1	Through Casing at 278.4	SIGNIFICANT PROBLEMS
P-303 (Also P-303A-D, see table D-2)	5 JAN 77	22 FEB- 23 FEB 77	213.0	121.3	Hit Casing	SIGNIFICANT PROBLEMS

TABLE D-1, CONTINUED

PHASE I
PRIMARY ELEMENTS
PLACED WITH WOODEN SPHERE

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
SP-285	14 MAY 77	20 JUN- 21 JUN 77	100.4	100.5/ 102.8	Through Casing at 100.5	GOOD CONCRETE
P-465 (Also P-465A-B, see table D-2)	19 MAY 77	14 FEB- 3 MAR 78	213.5	212.6	Plugged in Wood Ball	SIGNIFICANT PROBLEMS
P-341	18 JUL 77	6 FEB- 13 FEB 78	213.2	212.7	Hit Casing	U.L. 212.2 to 212.5, Probably from Loosely Cemented Aggregate
P-427	19 AUG 77	25 AUG- 26 AUG 77	213.3	136.7	Check Zone of Lost Seal Only	SIGNIFICANT PROBLEMS
P-313	8 SEP 77	6 JAN- 1 FEB 78	213.1	195.7	Hit Casing	SIGNIFICANT PROBLEMS

PHASE I
SECONDARY ELEMENTS
PLACED WITH BASKETBALL

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-474	18 JUN 76	6 AUG- 9 AUG 76	212.8	213.1/ 213.5	Limestone Below 213.1	SIGNIFICANT PROBLEMS
S-512	14 JUL 76	18 AUG-20 AUG 76	212.7	212.5/ 216.1	Limestone Below 212.5	Loss of 0.1'at contact. Probably loosely cemented sand washed out in drill water.
S-234	15 SEP 76	1 JUN- 7 JUN 77	217.8	217.9/ 219.1	Limestone Below 217.9	Loss of 0.1' at contact, otherwise good concrete.
S-268	23 NOV 76/ 14 DEC 76	4 FEB- 5 FEB 77	212.5	65.0	Check Zone of Lost Seal Only	Tremie pipe stuck during placement. Stopped placement,allowed conc. to set up. Cleaned element and completed placement. Good conc. outside tremie pipe.
S-268A	SAA	5 FEB- 7 FEB 77	212.5	160.2	Check Zone Below Tremie Pipe only	Loss of 2.0' in poorly cemented segregated sand inside tremie pipe. Good concrete below pipe.

TABLE D-1, CONTINUED

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-266	22 DEC 76	8 FEB- 10 FEB 77	212.5	212.7/ 222.9	Limestone Below 212.7	Slightly water cut 210.2 to 211.5, otherwise good concrete.
S-528	1 FEB 77	5 MAY- 16 MAY 77	213.0	212.6/ 214.1	Limestone Below 212.6	50% normal aggregate from 158.0 to 170.0. Loss of 0.6' near bottom due to honey-combing and sand washing out in drill water.
S-432	4 FEB 77	5 APR- 6 APR 77	213.1	213.5/ 215.8	Limestone Below 213.5	Loss of 1.0' at bottom,.(prob. sand and/or clay washed out in drill water). Tight hole by static water test.
S-442	22 FEB 77	3 MAY- 10 MAY 77	212.5	193.3/ 202.1	Ran Out Side Into Limestone	GOOD CONCRETE
S-522	22 FEB 77	18 APR- 20 APR 77	213.3	213.3/ 219.3	Limestone Below 213.3	0.8' loose aggregate at bottom before running into limestone.
S-114	2 MAR 77	24 MAY- 31 MAY 77	277.9	179.2	Ran Out Side Into Clay	50-75% normal aggregate content in several zones throughout (well-cemented)

PHASE I
SECONDARY ELEMENTS
PLACED USING WOOD SPHERE (AS WERE ALL REMAINING ELEMENTS)

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-200	14 APR 77	17 MAY- 24 MAY 77	246.2	242.0/ 247.8	Ran Out Side Into A.S.G.	GOOD CONCRETE
S-108	11 MAY 77	8 JUN- 16 JUN 77	278.3	278.5/ 281.8	Limestone Below 278.5	Loosely cemented aggregate and poorly cemented sand from 278.3 to 278.5.
SS-202	14 MAY 77	16 JUN- 20 JUN 77	95.4	95.3/ 97.1	Limestone Below 95.3	Loss of 0.1' at contact, 50-75% normal aggregate 23.2-29.0 and 41.5-46.5.
S-462	21 JUN 77	7 APR- 11 APR 77	212.8	212.8/ 216.3	Limestone Below 212.8	GOOD CONCRETE, Wood ball cored 212.2-212.7.
S-156	6 AUG 77	30 SEP- 7 OCT 77	277.7	275.9/ 279.5	Ran Out Side Into Rock	SIGNIFICANT PROBLEMS

TABLE D-1, CONTINUED

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-138	12 AUG 77	13 SEP- 15 SEP 77	277.5	209.5/ 216.4	Ran Out Side Into Rock	25-75% normal aggregate content in several zones throughout core.
S-392	23 AUG 77	22 MAR- 29 MAR 77	213.0	212.9/ 218.8	Limestone Below 212.9	0.7' loosely cemented aggregate at contact
S-168	24 AUG 77	27 SEP- 29 SEP 77	277.5	109.1/ 113.1	Ran Out Side Into Clay	50% normal aggregate in several zones.
S-168A	SAA	10 OCT- 14 OCT 77	277.5	191.8/ 198.9	Ran Out Side Into Clay	GOOD CONCRETE
S-186	1 SEP 77	24 OCT- 27 OCT 77	267.2	266.2/ 268.7	Ran Out Side Into Rock	0.5' loss at contact,(prob.sandy grout washed out in drill water).
S-370	11 OCT 77	15 MAR- 20 MAR 78	212.7	212.0/ 219.4	Ran Out Side Into Rock	Loose aggregate with traces of poor cementation at contact. (0.2')
S-278 (Also S-278A-B, See Table D-2)	13 OCT 77	3 MAR- 7 MAR 78	213.1	212.5/ 219.4	Ran Out Side Into Rock	SIGNIFICANT PROBLEMS
S-220	27 OCT 77	1 MAR- 2 MAR 78	217.5	218.6/ 221.6	Limestone Below 218.6	GOOD CONCRETE
S-292	4 NOV 77	8 MAR- 13 MAR 78	213.0	206.3/ 209.1	Ran Out Side Into Rock	GOOD CONCRETE
S-352	11 NOV 77	14 MAR- 15 MAR 78	212.5	113.8/ 119.2	Ran Out Side Into A.S.G.	GOOD CONCRETE
S-502	16 NOV 77	14 APR- 19 APR 78	212.6	177.0/ 182.1	Ran Out Side Into Clay	Less than 25% normal aggregate distribution 89.9-93.0'.
S-242	17 NOV 77	20 DEC- 21 DEC 77	212.5	99.2/ 104.2	Ran Out Side Into Clay	25-50% normal aggregate distribution in several zones.
S-326	13 DEC 77	13 MAR- 14 MAR 78	213.0	138.1/ 144.0	Ran Out Side Into Clay	GOOD CONCRETE

TABLE D-1, CONTINUED

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-482	5 JAN 78	13 APR- 19 APR 78	212.5	212.4/ 216.0	Limestone Below 212.4	50-75% normal aggregate distribution in several zones.
S-412	6 JAN 78	20 MAR- 21 MAR 78	212.6	115.1/ 119.3	Ran Out Side Into Clay	50% normal aggregate distribution 77.8-91.3'.
PHASE II PRIMARY ELEMENTS PLACED WITHOUT RETARDED MIX						
P-761	4 JAN 78	1 MAY- 5 MAY 78	213.0	213.0	N/A	GOOD CONCRETE
P-797	2 FEB 78	24 APR- 16 MAY 78	213.3	212.8	Hit Casing?	SIGNIFICANT PROBLEMS
P-845	31 MAR 78	9 MAY- 10 MAY 78	249.9	107.8	Hit Casing	GOOD CONCRETE
P-805 (Also P-805A, see table D-2)	3 APR 78	15 JUN- 16 JUN 78	213.3	108.9	Hit Casing	SIGNIFICANT PROBLEMS
P-773 (Also P-773A-B, see table D-2)	3 APR 78	5 JUN- 5JUL 78	213.1	100.0	Hit Casing	SIGNIFICANT PROBLEMS
P-571	5 APR 78	28 JUN- 5 JUL 78	213.2	213.0	N/A	Scattered areas of honeycomb
PHASE II PRIMARY ELEMENTS PLACED USING RETARDED MIX						
P-611	9 JUN 78	28 JUL- 3 AUG 78	212.8	212.7	N/A	Scattered areas of honeycomb
P-1001	13 JUN 78	25 JUL- 26 JUL 78	173.3	104.9	Hit Casing	GOOD CONCRETE
P-985	14 JUN 78	26 JUL- 27 JUL 78	173.2	119.0	Hit Casing	GOOD CONCRETE
P-1017	23 JUN 78	7 AUG- 21 AUG 78	172.7	120.5	Hit Casing	GOOD CONCRETE
P-989	12 OCT 78	26 FEB- 1 MAR 79	173.1	145.9	Hit Casing	GOOD CONCRETE

TABLE D-1, CONTINUED

PHASE II
SECONDARY ELEMENT
PLACED WITHOUT USING RETARDED MIX

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-552	13 FEB 78	11 MAY- 16 MAY 78	213.2	109.2/ 110.6	Ran Out Side Into Clay	GOOD CONCRETE

PHASE II
SECONDARY ELEMENTS
PLACED USING RETARDED MIX

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-626	12 MAY 78	13SEP- 14 SEP 78	212.5	78.0/ 79.4	Ran Out Side Into Clay	GOOD CONCRETE
S-724	17 JUN 78	13 SEP- 15 SEP 78	212.8	212.2	Plugged in Wood Ball	Slight segregation 169-172', and 179.6 to 182.7'.
S-926	21 JUN 78	21 DEC 78-16 JAN 79	218.8	119.9/ 124.2	Ran Out Side Into Clay?	GOOD CONCRETE
S-660	5 JUL 78	18 SEP- 21 SEP 78	212.8	117.6/ 119.3	Ran Out Side Into Clay	GOOD CONCRETE
S-576	13 JUL 78	22 AUG- 28 AUG 78	212.5	210.0/ 212.4	Ran Out Side Into Rock	GOOD CONCRETE
S-634	12 SEP 78	25 OCT- 27 OCT 78	213.0	213.0/ 213.9	Limestone Below 213.0	GOOD CONCRETE
S-682	27 OCT 78	11 DEC- 15 DEC 78	212.8	212.9/ 215.4	Limestone Below 212.9	GOOD CONCRETE
S-706	1 NOV 78	18 DEC- 21 DEC 78	212.6	212.4/ 214.1	Limestone Below 212.4	SIGNIFICANT PROBLEMS
S-852	8 DEC 78	7 MAR- 9 MAR 79	259.9	140.5/ 144.0	Ran Out Side Into A.S.G.	GOOD CONCRETE
S-890	31 JAN 79	1 AUG- 7 AUG 79	256.9	230.0	Ran Out Side Into A.S.G.	GOOD CONCRETE

TABLE D-1, CONTINUED

ELEMENT NO.	DATE CONCRETE PLACED	DATES CORED	DEPTH HOLE	DEPTH CORED	REASON IF SHORT	REMARKS
S-942	28 FEB 79	18 JUL- 23 JUL 79	178.5	178.4/ 179.4	Limestone Below 178.4	GOOD CONCRETE
S-1046	8 JUN 79	23 JUL- 24 JUL 79	172.5	86.1/ 89.3	Ran Out Side Into A.S.G.	GOOD CONCRETE
S-1012	20 JUN 79	24 JUL- 27 JUL 79	172.7	142.1	Ran Out Side Into Rock	GOOD CONCRETE
S-1088	26 JUN 79	31 JUL- 1 AUG 79	172.6	110.7/ 114.2	Ran Out Side Into A.S.G.	GOOD CONCRETE

TABLE D-2

TEST CORES WHICH REVEALED POSSIBLE SIGNIFICANT PROBLEMS

P-451. P-451 was the first element to be placed which was subsequently test cored. No difficulties were reported during placement. Information from the concrete placement form showed that the tremie pipe was initially raised three feet off the bottom and that no slump or air content tests were run.

Very good concrete was logged for the first 132.5 feet. Scattered throughout the remainder of the core were several small pockets of variously segregated structures, including loose aggregate, less than normal aggregate quantity and honeycombing, bud all showing evidence of cementation. One zone of slightly less than two feet of lost core was encountered, described as sand washing out in drill water. Drilling was stopped when the bit hit the bottom of the permanent casing at 212.6 feet.

The hole was subsequently washed and backfilled with 1:1 by volume neat cement grout. Grout began flowing from the top of the hole after approximately 13 cubic feet had been pumped. The volume of an NQ hole to 212.6 feet is less than 11 cubic feet.

P-473. This element was placed with the tremie pipe initially set 3.7 feet off the bottom. Slump was recorded as 8 inches, air as 7.5%. No difficulties were reported.

The first 30 feet of core showed poor quality concrete, with segregated grout, sand and honeycomb structures. The remainder of the core showed occasional moderate to slight honeycomb structures and four small pockets of segregation consisting of grout and loose aggregate.

The hole was washed thoroughly and backfilled with a 3:1 neat grout using one pound of Intraplast "N" per bag of cement. Intraplast "N" is a chemical additive normally used in pressure grouting operations to retard set and allow greater penetration. It was hoped that the thin mix plus the additive would cause greater saturation of the more porous, less the normally cemented zones.

Two days later, the hole was taped and found to measure 170 feet, with some resistance met at 105 feet. Grout pipe was inserted to 126 feet and rebackfilled with the same mix. The hole was topped off a final time after having settled to about 20 feet.

P-541. During placement of this element the tremie pipe was initially set at 2.5 feet off the bottom. The slump was recorded as 6 inches and the air at 6.5%. A 35 minute delay was experienced before batch number 3, with the top of concrete at 102 feet.

The test core showed segregation from 50 to 114 feet, and again from 209 to 212.1 feet where the casing was hit. The segregated zones

included sandy concrete with less than normal coarse aggregate, lost core with sand having washed out in the drill water, neat grout and loose aggregate. Various degrees of honeycombing were also noted. Total lost core measured 0.9 feet.

The hole was later washed and backfilled with a 0.75:1 neat grout. Grout broke the surface after approximately 10 cubic feet had been pumped. The volume of an NQ hole to 212.1 feet is slightly greater than 10 cubic feet.

P-509. During placement, the tremie was initially set at 2.5 feet off the bottom. Slump was recorded as 6.5 inches and air at 6.5%. There were no difficulties reported in the placement.

The test core log showed a 0.1 foot unaccounted loss in a 3 foot zone of a badly honeycombed structure, and a 4 foot loss with sand washing out in drill water prior to the bit hitting bottom of casing (208.7-212.5 feet). Other than those discrepancies and some minor segregation in the top portion of the concrete, only minor honeycombing was encountered.

The hole was backfilled with no excess quantity of grout. A 3:1 mix with Intraplast was used.

P-251. This element was placed with no difficulties or delays noted. Initial tremie setting was 1.2 feet above the bottom. The slump was recorded as 7.5 inches and the air at 6.9%.

The entire test core was spotted intermittently with honeycomb structures ranging from slight to high. There were several instances of less than normal aggregate, but in well cemented concrete. Three pockets of segregation are worth noting: A zone of less than 3 feet of loose coarse aggregate of which 0.1 foot was called an unaccountable loss; a 0.2 foot zone of loose coarse aggregate; and 0.3 foot of unaccountable loss at the bottom of the hole adjacent to the casing. The bit intercepted the casing at 212.8 feet.

The hole was washed and backfilled with a 1:1 neat grout with no excess noted.

P-507. This element was placed with the tremie initially set at 0.6 feet off the bottom. There were in difficulties in the placement. The first batch was described as wet, the remainder were hood.

Many zones of segregation were seen in the core. Zones of honeycomb, loose coarse aggregate and sandy grout occur throughout. Two zones of lost core are shown and appear to be sand washed out in drill water. The casing was intercepted at 134.5 feet in a zone of lost core. No redrill was attempted.

The hole was washed to its original depth and backfilled with 1:1 neat grout. No indication was made of how much grout it actually took to fill the hole.

P-179. The concrete was placed with no difficulties. The tremie

pipe was placed approximately 0.9 feet above the bottom of the casing. The slump was recorded as 6.0 inches and the air at 5.5%. The concrete was cored to the bottom to the casing, 277.6 feet in depth. Good quality concrete was recovered to 147.6 feet. Below that depth several zones of segregated materials were encountered consisting mainly of loose coarse aggregate, honeycomb structures, and less then normal aggregate. Lost core was manifest in 3 sections of segregation and was described as sand washed out in drill water. About 2 feet of loose aggregate was lift in the hole as indicated by rough drill action and core barrel markings. At 277.6 feet the bit and reamer twisted off and was left in the hole. This bottom zone was probably a poorly cemented, washed concrete, and as the sand was washed by the drill water the loose aggregate preceded the bit with a rolling action helping disintegrate the vertically adjacent concrete. The loose aggregate then continued to increase and build up torque on the drill stem. This aggregate, having nothing to hold it in the inner barrel, settled to the bottom of the hole when the stem was pulled. This also probably explains those zones of loose aggregate recovered in many of the other holes at various depths, retrievable at any depth below which good concrete was cored.

Grout pipe was washed to 277 feet and the hole cleaned thoroughly. It was then backfilled with a 3:1 mix using 1 pound Intraplast "N" per bag of cement. The next day it was noted that the hole had set up only to 128 feet. It was backfilled with a neat 1:1 mix using 1 pound of the additive per bag. No volumes were recorded.

<u>P-109.</u> While placing concrete in this element, a tremie pipe blockage was experienced with the bottom of the pipe at 155 feet. The entire pipe was subsequently removed from the hole, breaking the seal. The pipe was cleared, reinserted and the pour continued. Poor quality concrete resulted from the broken seal and the subsequent mixing and agitation.

The concrete was cored through the entire element and into limestone. Much of the concrete above 256 feet was observed to be in a state of segregation, with sand and coarse aggregate pockets, honeycomb and water cut structures abundant.

It was attempted to wash the hole to prepare for backfilling, but difficulties were encountered which forced abandonment of the hole below 165 feet. It was backfilled to 165 feet with 1:1 neat grout, and when set was obtained, was redrilled to 282 feet and regrouted the entire depth.

To recheck the hole, it was cored again, reaching only 176.4 feet, ruining 3 new bits in the last 17 feet. Having seen enough core to confirm the necessity of major repair, the Corps directed the contractor to correct the faulty concrete.

ICOS redrilled the element to 256.9 feet, below which the core indicated good concrete, They utilized a Hughes drill with a 24 inch roller bit. 37.5 cubic yards of concrete were replaced with no further difficulties.

P-303. This element was the second of three primary elements to suffer from a broken seal during placement. With the bottom of the tremie pipe at 115 feet and the top of concrete at 102 feet, the pipe was raised in an attempt to free concrete which had filled the pipe and hopper. The pipe refused to go back down. It was then necessary to pull the pipe intirely from the hole, breaking the seal. 102 feet of pipe was reinserted into the hole, raised one foot, and the pour completed. It was noted that the first batch may have been too dry. The slump and air in the fourth batch were measured at 7.5 inches and 6.75%.

The concrete was cored with very poor quality obtained in the vicinity of the broken seal. From 80 to 121.3 feet (where drilling was terminated due to hitting casing) the concrete was badly honeycombed, water out, and there were several areas of loose aggregate and lost core where the sand had washed out in the drill water.

The hole was washed and backfilled with a 0.75:1 neat grout. Substantially more grout was needed than the computed volume of an NQ hole to that depth.

The element was later recored from a different position. The same general results were obtained; the bad zones tended to match, although the vertical dimensions and exact nature of the core differed. There was considerably more lost core from 100 to 120 feet on the second boring. The casing was hit at 147.8 feet, halting drilling.

Since the poor quality concrete was of an extreme nature, the Corps directed the contractor to correct the element to 140 feet. The nature of the concrete below 147 feet was not known, the variable hardness of the previously cored concrete making vertical alignment very difficult for the drill stem. The concrete below 140 feet would be recored after the contractor opened the element to 140 feet. ICOS used the Hughes drill and 24 inch roller bit. The final depth drilled was 140.2 feet.

Two attempts were made to core the lower portion of this element from 140.2 feet. Each attempt resulted in casing interception after approximately 6 feet. To start a straight hole ICOS inserted 140 feet of tremie pipe in the hole, stabilized with fins. Drilling inside the pipe, core was obtained to 192.4 feet. No lost core was encountered. The core showed several zones of honeycomb structures and several zones of loose aggregate with signs of cementation. The lowest zone of loose coarse aggregate with signs of cementation. The lowest zone of loose coarse aggregate was 188.8 to 190.6 feet. This aggregate kept falling back into the hole, causing the ruining of two new bits. The drill was pulled off the hole at this point. On analysis of the core, mechanical action of aggregate below the bit was determined to be the causative agent in core segregation. Cementation is apparent on the aggregate and it is believed to have been intact before drilling.

The core hole was cleaned and backfilled with a 1:1 neat grout and 20 cubic yards of tremie concrete filled the element from 140.2 feet.

P-465. This is the first element to be cored which had concrete placed with the revised procedure initiated during Phase I. A wooden ball was used and the tremie pulled only 0.3 foot off the bottom. No

difficulties were reported during the placement. The air was reported to be 4.5% and the slump 7 inches.

The element was cored through the center of the element to 212.6 feet where the casing was intercepted. Only moderate honeycombing and occasional slight segregation were encountered to 113.6 feet. From 113.6 to 115.5 feet no core was recovered. This area was logged as sand washed out in drill water. No aggregate was recovered. Only minor discrepancies were described to exist in the core from 155.5 feet to the bottom. The wooden ball was cored and recovered from 212.0 to 212.6 feet.

In an attempt to recheck the zone from 113 to 155 feet, a new hole was drilled approximately 3 inches from the upstream edge of the casing. This hole intercepted the original hole at 57.5 feet and was abandoned. A third hole was drilled on the extreme downstream edge of the casing. It was taken to 164.7 feet, a sufficient depth below the bad zone. The only evidence of bad core was a zone from 126.5 to 130 feet where there was less than 50% normal coarse aggregate but good cementation.

The three holes were subsequently washed and grouted with a 1:1 neat mix. In an attempt to determine if the two deeper holes were connected, the water level in one was lowered while the other was being washed. The level of the water did not rise, indicating no significant communication. No further action was taken on this element.

<u>P-427.</u> This was the third primary to suffer a broken seal, and the first to use the revised procedure of halting placement, allowing the concrete to set, recleaning and then resuming placement.

Placement was halted with the concrete 77 feet below the top of casing due to a clogged tremie, which necessitated breaking the seal at that point. The concrete was cored from 77 feet to 136.7 feet with unsound concrete encountered from 77 feet to 115.7 feet. The contractor drilled out the concrete to a depth of 127 feet with a 24 inch bit and completed tremie operations.

<u>P-313.</u> P-313 was the last Phase I element placed which was test cored. It was placed with no difficulties noted.

The concrete cored was of good quality with only several zones of subnormal aggregate to a depth of 179.3 feet. From 179.3 to 189.0 feet a zone of unaccountable loss was recorded. Neither the geologist nor the driller noted any changes in drill action or speed. The bit, however, was very worn and was due to be replaced after that run. No aggregate was recovered on the next run. These facts indicate a cemented sandy zone is present at that depth which desintegrates when mechanical action of the bit combined with the water pressure needed at that depth act on the core. The worn nature of the bit probably contributed to the mechanical breaking and subsequent grinding as well. The hole was continued to 195.6 feet at which point the bit intercepted the casing.

The hole was washed and backfilled with 1:1 neat grout. No further action was taken.

S-474. This element contained a sequence of grout from 70.6 to 70.9 feet; followed by red clay from 70.9 to 71.3 feet; and back into grout from 71.3 to 74.1 feet. After examination of the core it was determined that the clay had fallen in from the side of the hole during placement. The hole was pressure tested for confirmation. The test indicated no leakage. It was subsequently reamed to 6 inches in diameter in order to run a closed circuit monitoring device down the hole. No apparent cavitation was found. The hole was backfilled and no further action was taken.

S-156. The test core showed 25 to 50% normal aggregate from 162.0 to 190.0 feet. The most significant anomaly, however, was an area of soft annular space grout 2.2 feet thick between the concrete and limestone contact. After drilling was completed an elbow was put on the grout pipe and the bottom of the hole was washed thoroughly. Some drill cuttings, gelled bentonite, and flakes of annular space grout were washed out. The hole was pressure tested and found to be reasonably tight. The hole was backfilled eight months later with 12 cubic feet of 1:1 neat grout. It was later determined that there probably was no significant problem, that the most probable explanation was that the bit had left the side of the element before encountering rock.

S-278. This element had two zones of lost core; from 196.9 to 199.4, and from 200.5 to 210.5 feet. Both losses were determined to be from the drill running into the annular space grout around P-279. The hole was rechecked by drilling two other test holes. These holes showed reasonably good concrete throughout. All three holes were backfilled the same day and during backfilling the holes were monitored to see if there was any communication. None was observed.

P-797. P-797 was the first element test cored during Phase II which was believed to have significant discrepancies in the concrete. the concrete was placed without retarder. The slump was recorded as 6.5 inches and the air content at 5.5%. The concrete temperature was 55 degrees F. Approximately 0.5 foot of sandy grout was observed as the concrete rose to the surface. The element was cored to the bottom of the casing at 212.8 feet.

The top 10 feet of concrete revealed aggregate content ranging from little or none at the top of the boring to a good distribution at the base of this zone. It remained of good quality to a depth of 70.2 feet where slight segregation was noted in a zone which extended to 89.4 feet. Good quality dominated the remainder of the hole with the exception of a one foot zone of loose cement coated aggregate from 136.0 to 137.0 feet. The hole was backfilled with 1:1 neat grout with no excess take recorded.

P-805. This element was placed without retarder. The slump and air content were not recorded. The concrete temperature was 69 degrees F. Less than one foot of sandy grout was noted as the concrete rose to the surface. The tremie placement was conducted without difficulty.

Zones of slight to moderate honeycomb were recorded between the start of the core at 2 feet to 39.2 feet. Good quality concrete was recovered from 39.2 to 75.0 feet were drill action became rough and broken core was recovered. The drilling continued although very rough drill action was noted and the core exhibited some segregation and honeycombing. Mechanical trouble occurred and probably resulted in an 8.3 foot core loss between 99.6 and 108.5 feet. The core ran into the side of the 26 inch casing at 108.9 feet. The core above this depth contained signs of washing and was of a somewhat reduced diameter indicating that the bit may have been following the side of the casing for 20 or 30 feet. The element was redrilled with the second boring reaching the bottom of the steel casing at 213.0 feet. The core recovered was of much better quality. The top 10.6 feet revealed some aggregate segregation and moderate honeycombing. From 13.1 to the bottom of the element only small scattered zones of segregation were present. Loose coarse aggregate with a cement coating was recovered in a narrow zone from 172.7 to 172.9 feet. All remaining core was solid and no core losses were recorded. The holes were backfilled using the emulsifier Intraplast "N" in a 3:1 neat grout mix. The borings were later topped off with 1:1 grout.

P-773. Concrete was placed without the retarder admixture. No problems were encountered during the placement procedures. It was noted that approximately one foot of sandy grout rose to the surface prior to seeing well mixed concrete. The slump and air content were not recorded. The temperature of the concrete was a constant 68 degrees F. This element was cored with three different attempts needed to penetrate the concrete to a sufficient depth to satisfy the testing program. The first boring hit the side of the 26 inch casing at 100.0 feet. The second attempt hit the casing at 85.0 feet. The third was drilled to some 1769 feet into the concrete before it also intercepted the side of the casing.

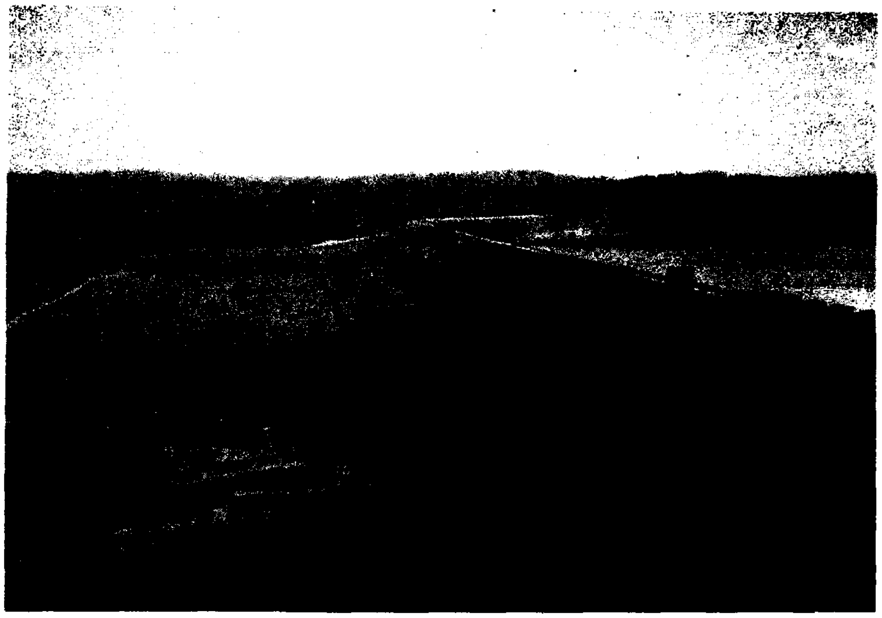
All three of the borings revealed slight to moderate honeycomb and different degrees of aggregate segregation. The most severe segregation occurred between 114.4 and 159.3 feet. Zones of broken concrete and in several cases loose aggregate were recorded, as was some unaccounted losses. In the zones where no core was recovered the drill return water contained excessive amounts of sandy grout and where aggregate only was recovered it was coated with cement mortar. Rough drilling was also noted in these zones. It is believed that although segregated, the concrete was solid until broken by the core drilling. The concrete beneath this zone was of good quality. The three bore holes were flushed clean and backfilled using a 3:1 neat grout with Intraplast "N". All holes were filled from a tremie pipe lowered into the deepest hole, indicating communication existed between the three. No further action was taken on this element.

S-706. Concrete was placed in this element with tests indicating a 7 inch slump and 6.75% air. The concrete temperature was 65 degrees F. The top 158 feet of core indicated good quality concrete. From 158.0 to 182.8 some slight segregation was noted in three small zones. The core was solid but contained only about 50% of the normal amount of coarse aggregate. At the contact some 0.4 foot of rounded quartz and limestone pebbles were recovered. A falling head test showed a tight hole. The hole was backfilled and no further action was taken on the element.

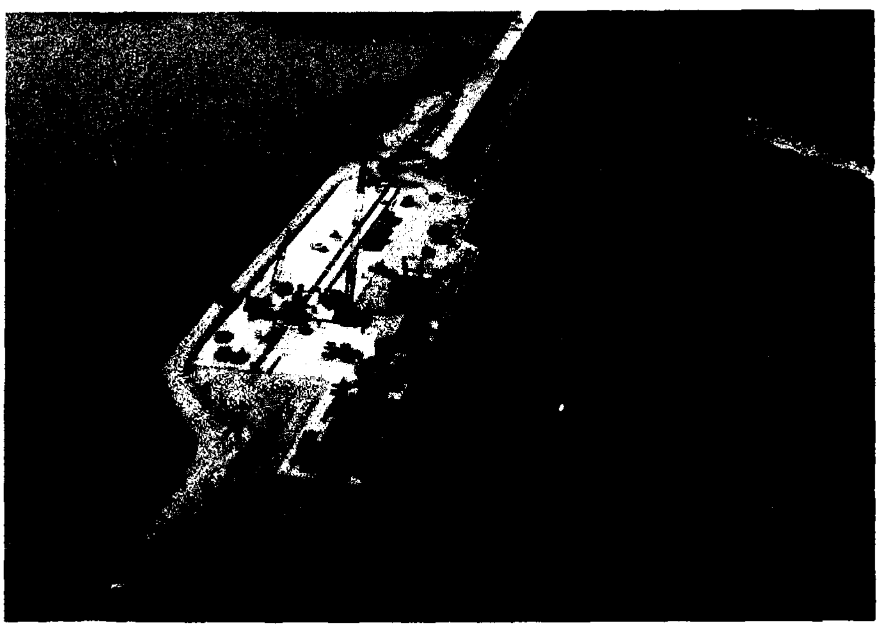
APPENDIX E

CONSTRUCTION PHOTOGRAPHS

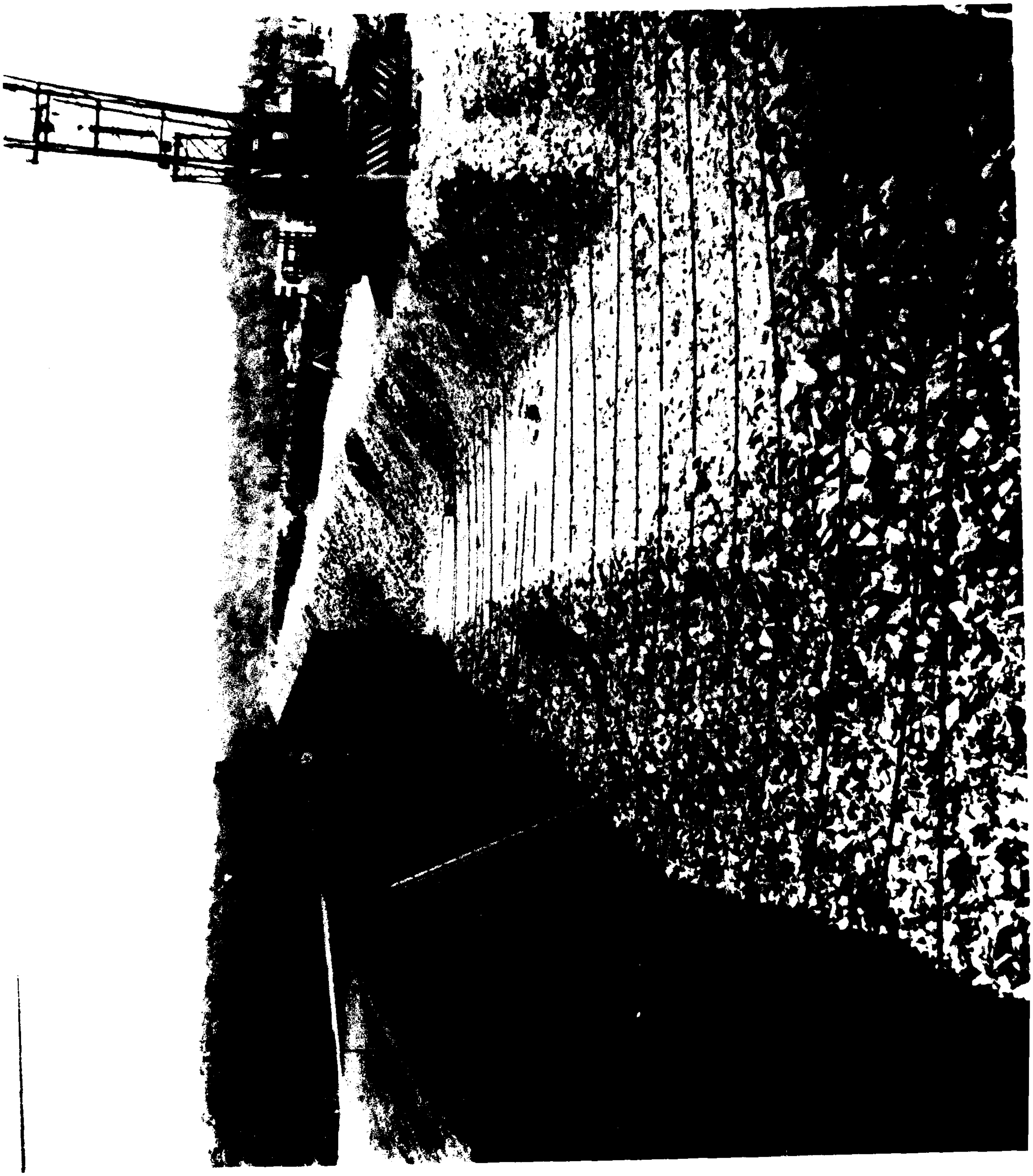
1. Aerial view of Wolf Creek Dam with concrete diaphragm wall work platform under construction.



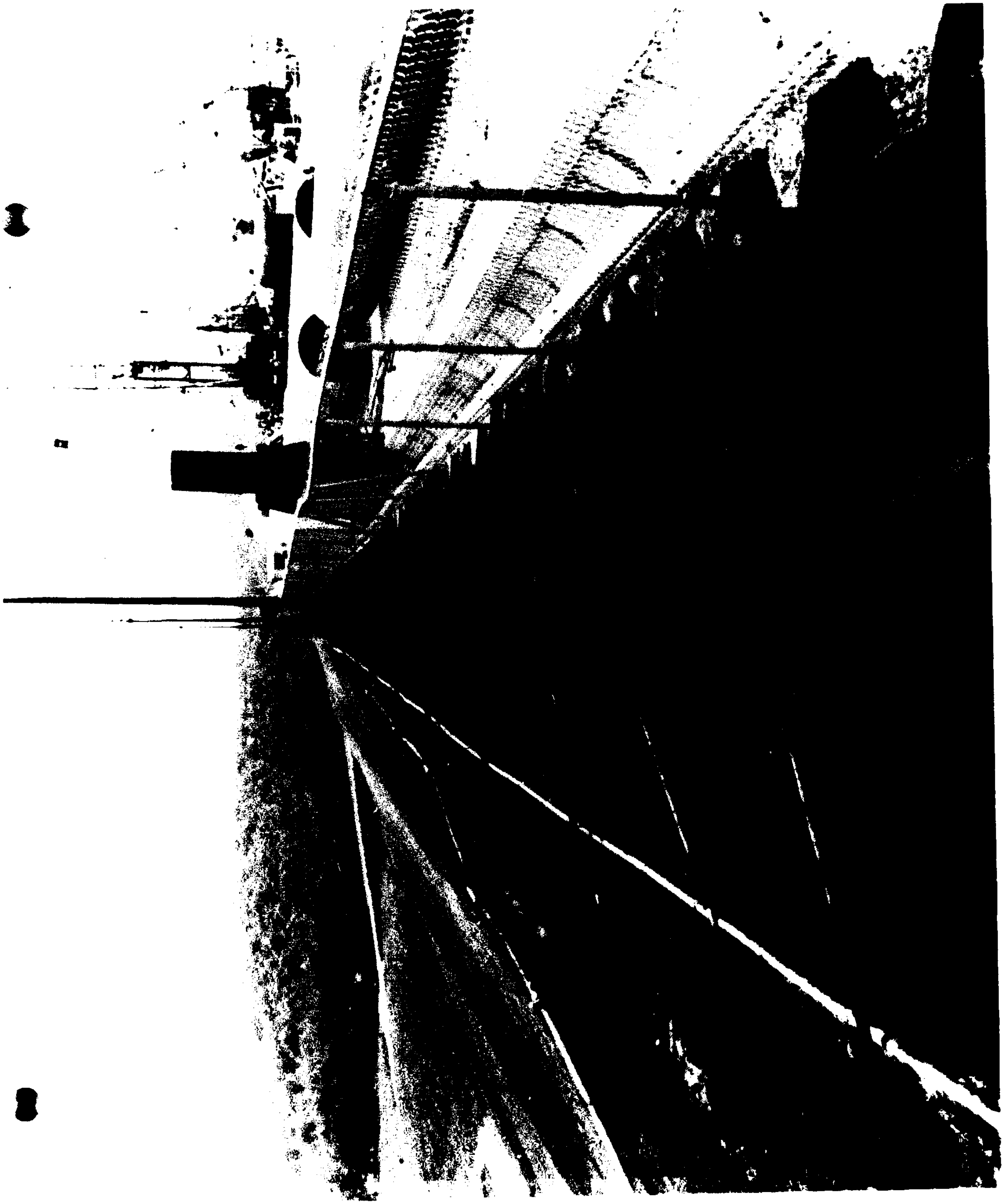
2. Wolf Creek Dam before wall construction.



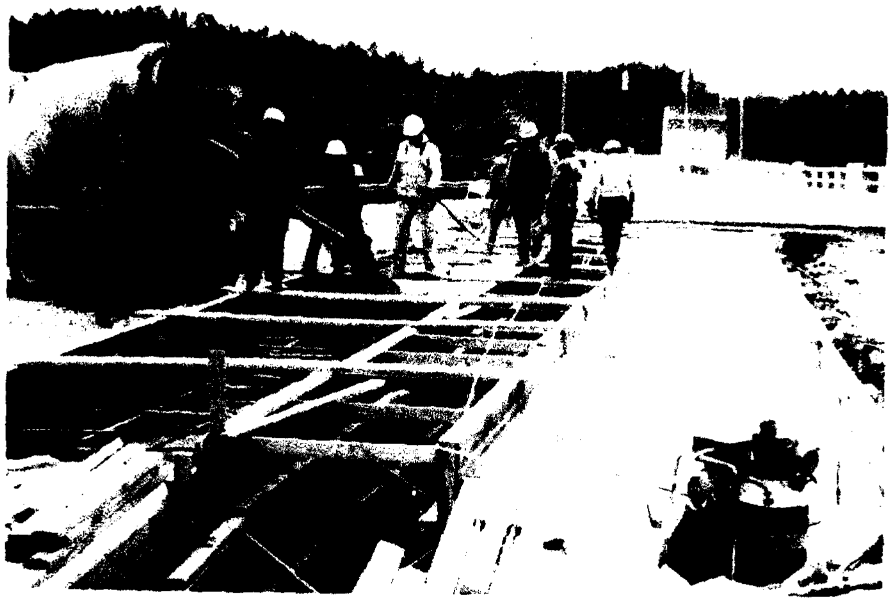
3. Embankment work platform,
Phase I.



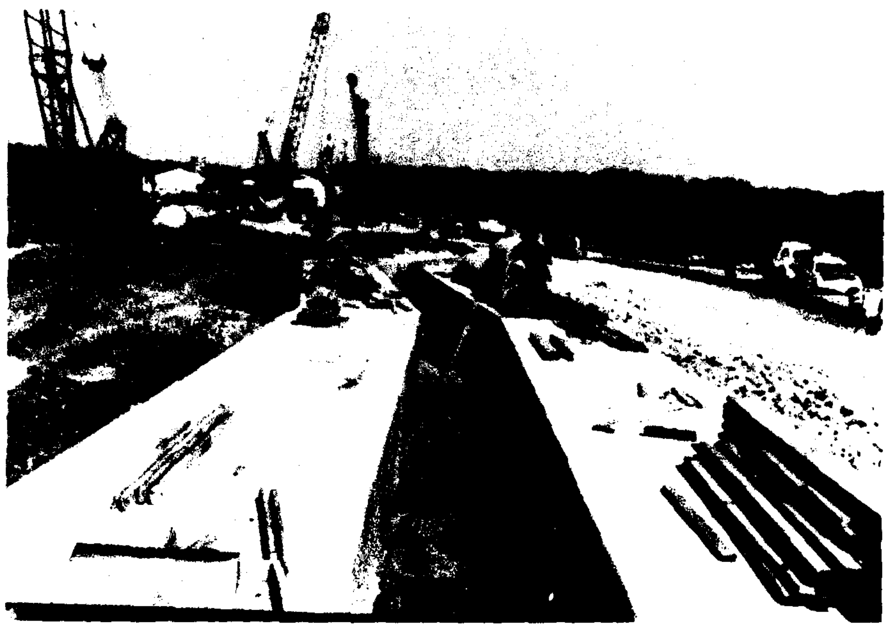
4. Downstream piling and anchor rods.



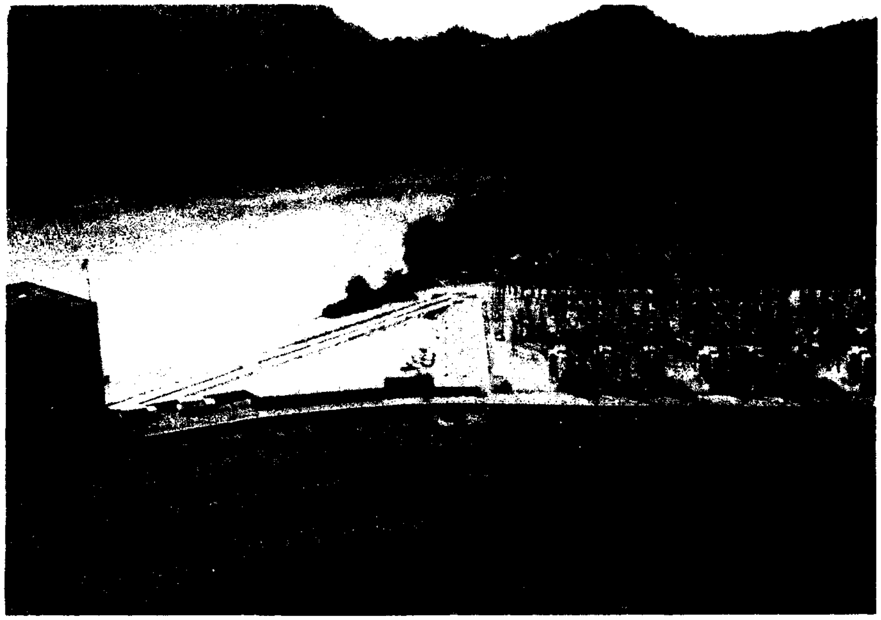
5. Downstream piling, platform construction construction completed. Note anchors stressed and drainage system.



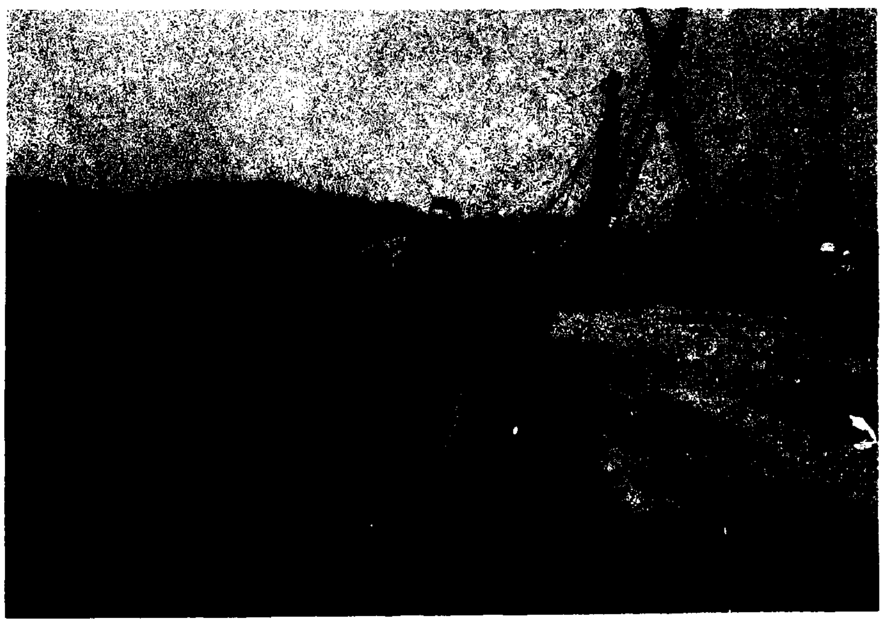
6. Placing guidewalls.



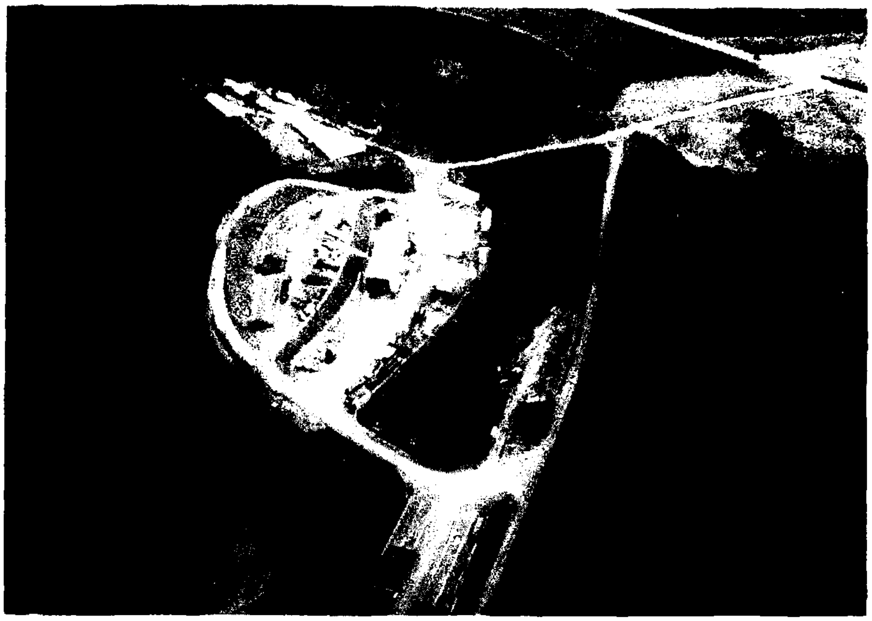
7. Concrete guidewalls. Note offset for tailtower section.



8. Switchyard guidewalls.

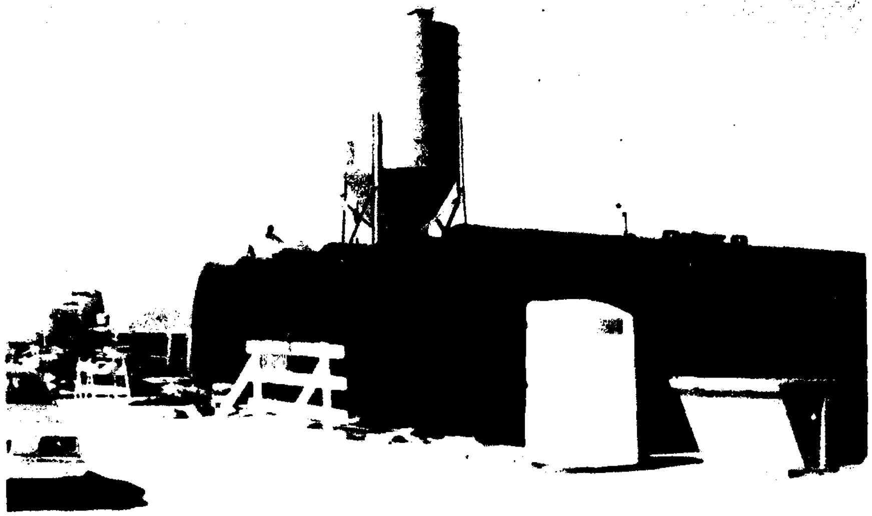


9. Detour of U.S. Highway 127 around embankment work platform. (With slight mishap.)

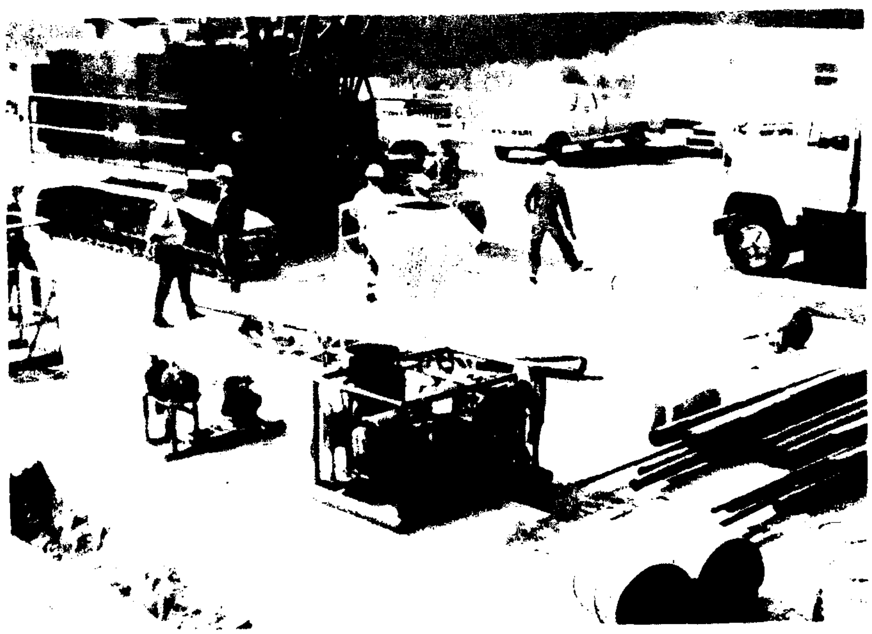


10. Contractor's work area and office complex with government offices and laboratory at top.

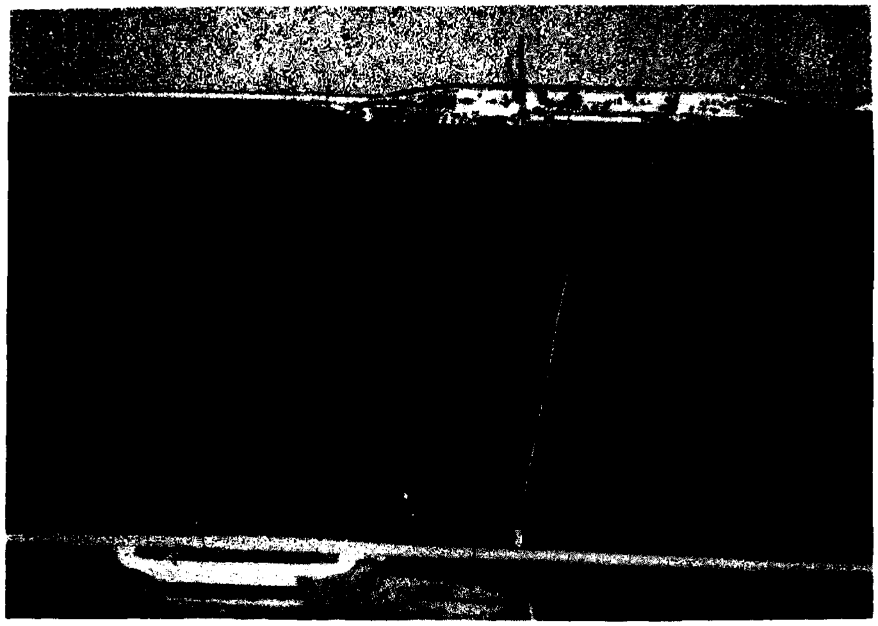
11. Prime contractor brought in equipment from world wide locations.



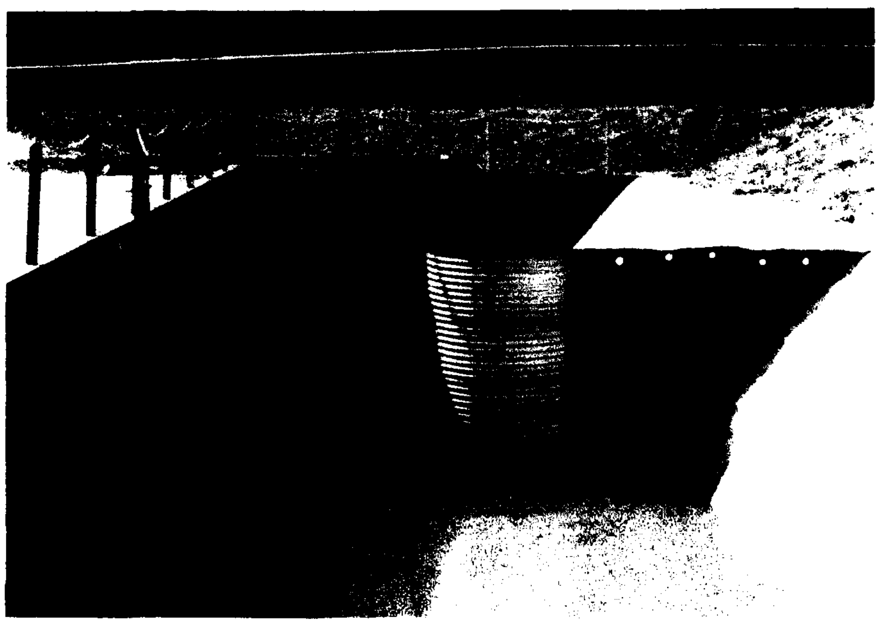
12. Bentonite plant - Storage, mixing units and pumps.



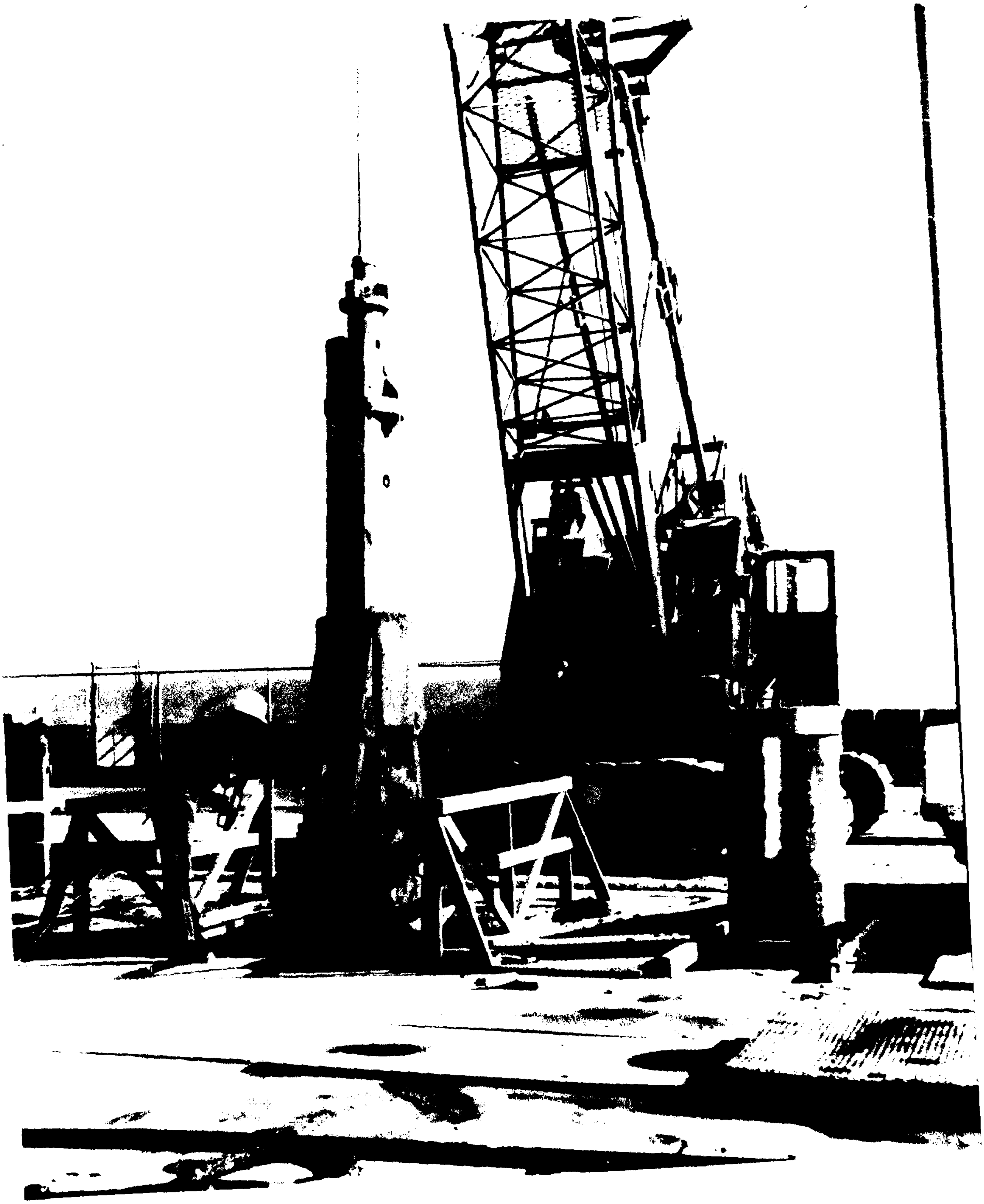
13. Portable emergency cyclone slurry mixer.



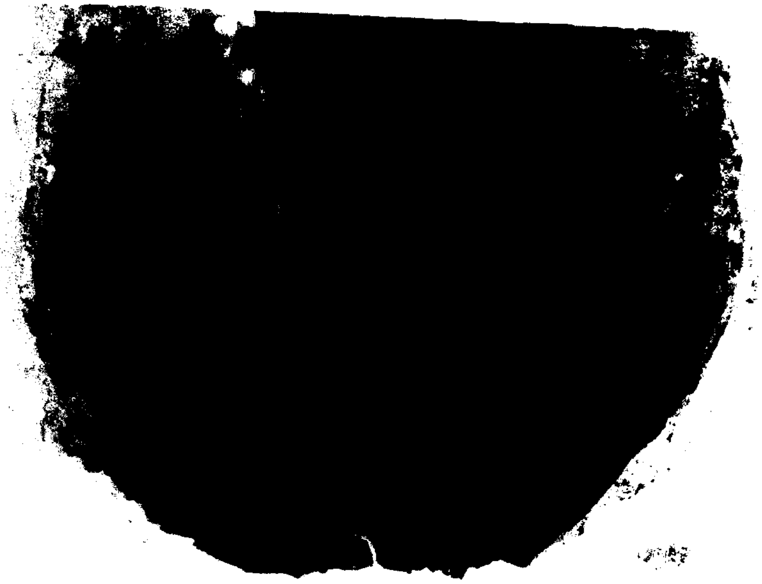
14. Contaminated slurry treatment pond - below work platform at base of embankment.



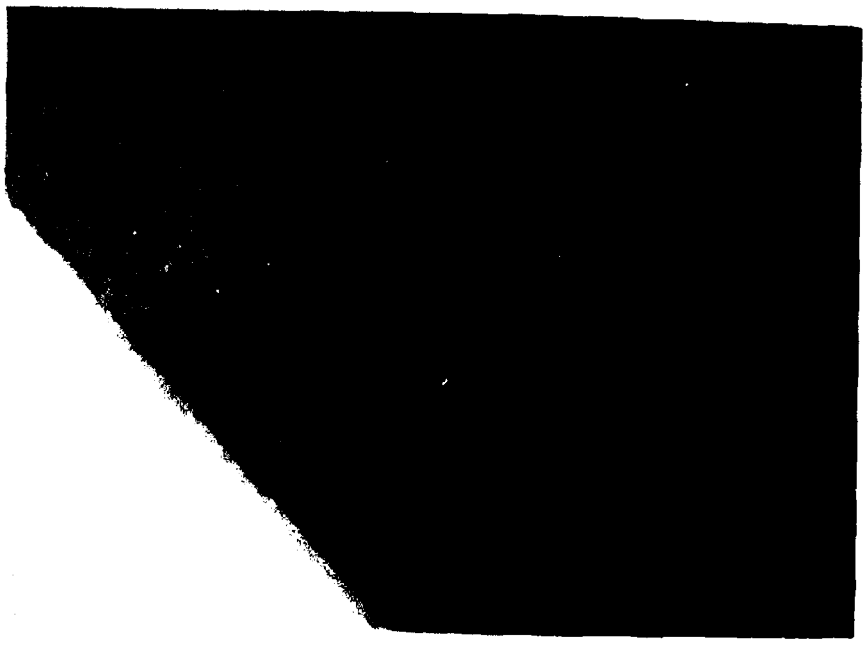
15. Close-up of bentonite treatment plant.



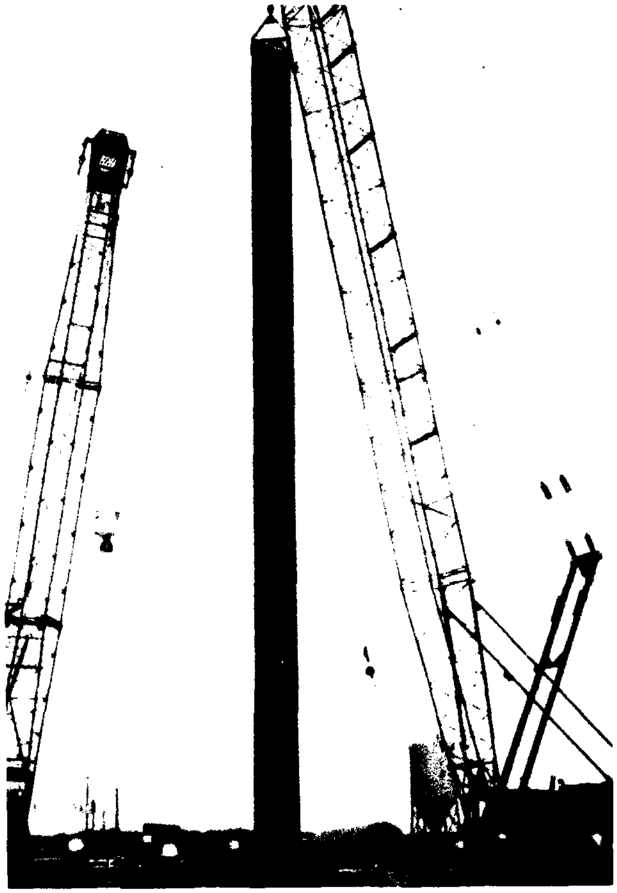
16. Begin primary element excavation.



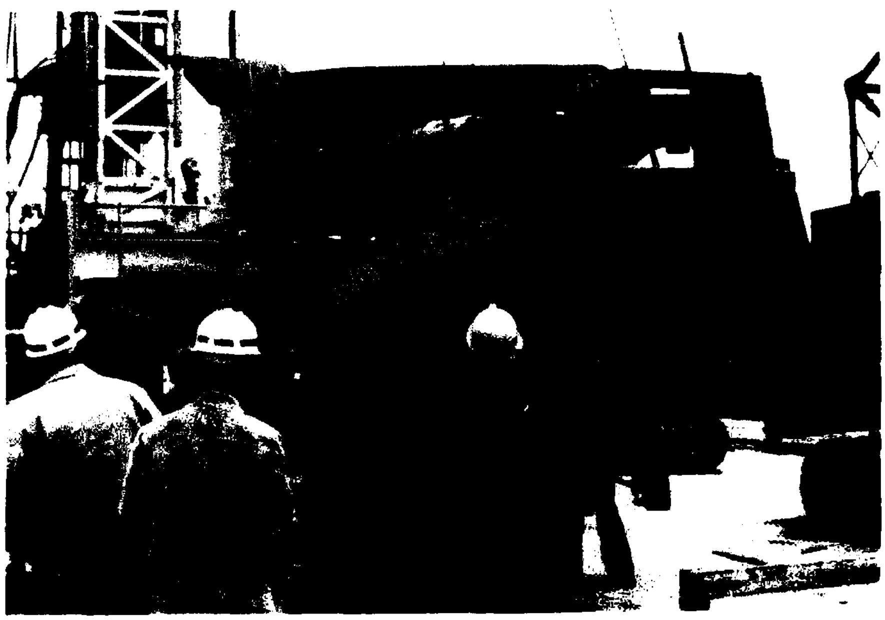
17. 53" open excavation to 76'.



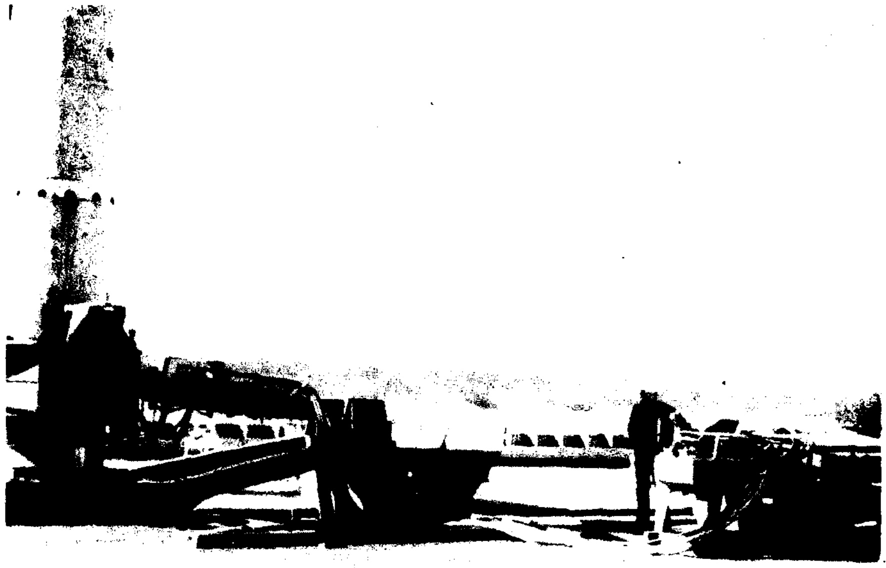
18. Primary element filled with slurry.



19. 80' section of 47" casing placed in hole.



20. Casing driver placed over casing and anchored in place.



21. Casing driver in operation.

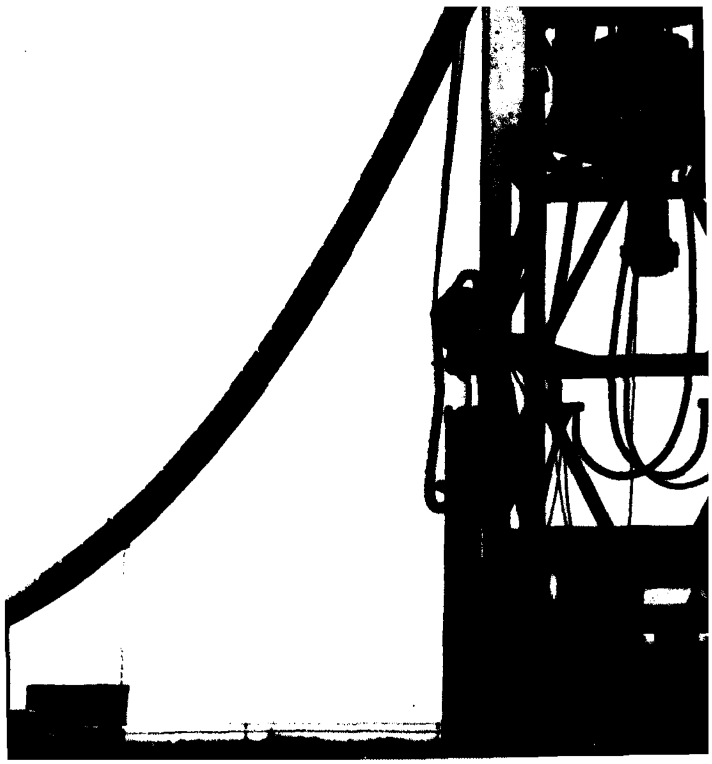
22. Adding section of casing as hole advances - note flush joint casing and coupling method.

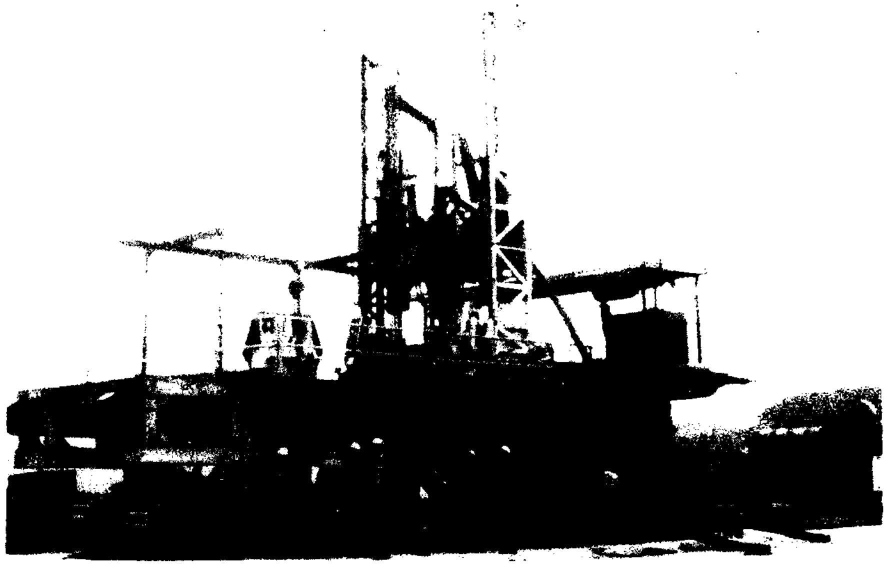
23. General view of primary overburden excavation.

24. Spoil hauled to waste area in hoppers by load lugger trucks.

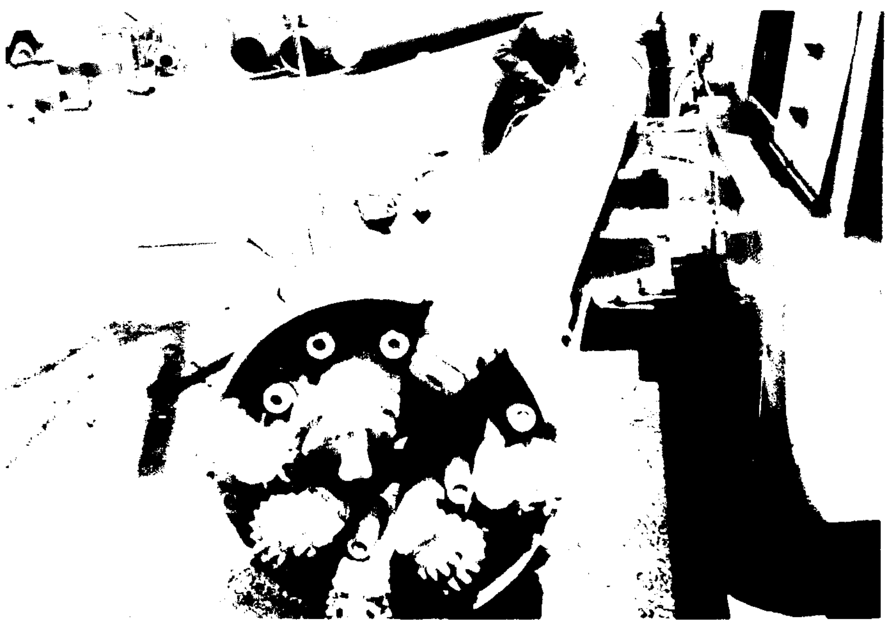
25. At approx. 124', 41"casing telescoped through the 47" casing and advanced to top of rock.

26. Toothed bottom section of casing for rock seal.





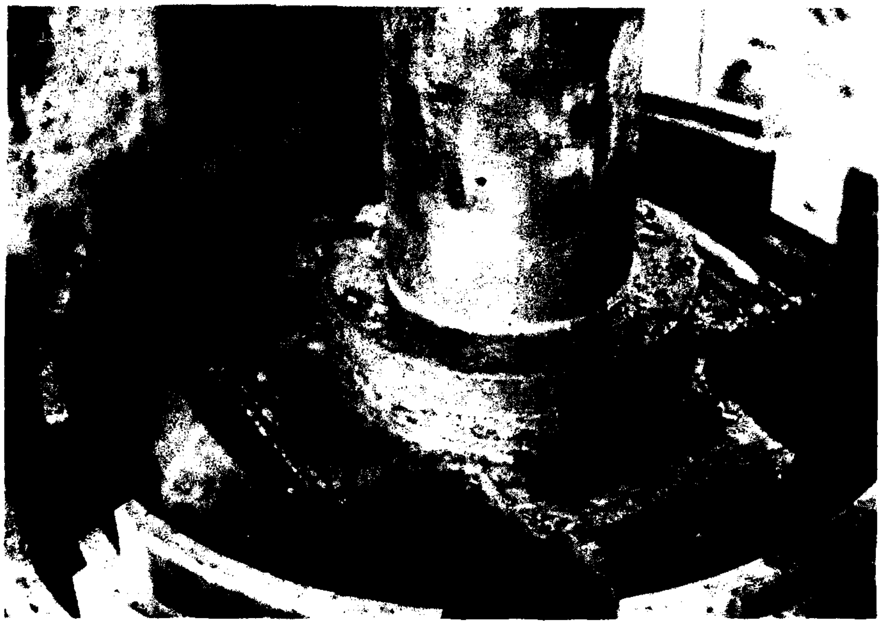
28. Hughes Shaft Drill for large hole drilling - us by subcontractor on Phase I embankment portion of contract, exclusive of tie-in section.



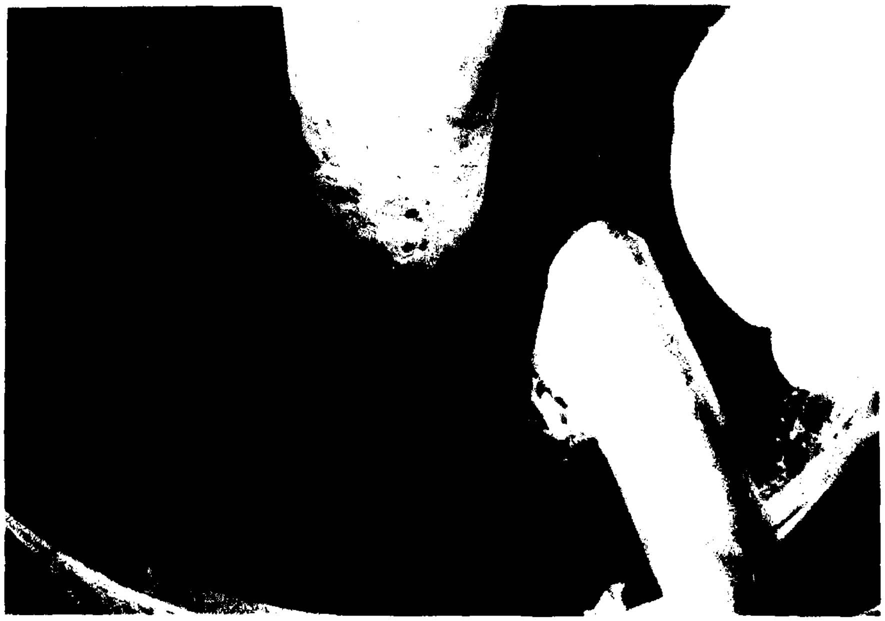
29. Typical 36 roller rock bit used on primary rock excavation.

30. Double wall drill rods used for air lift circulation.

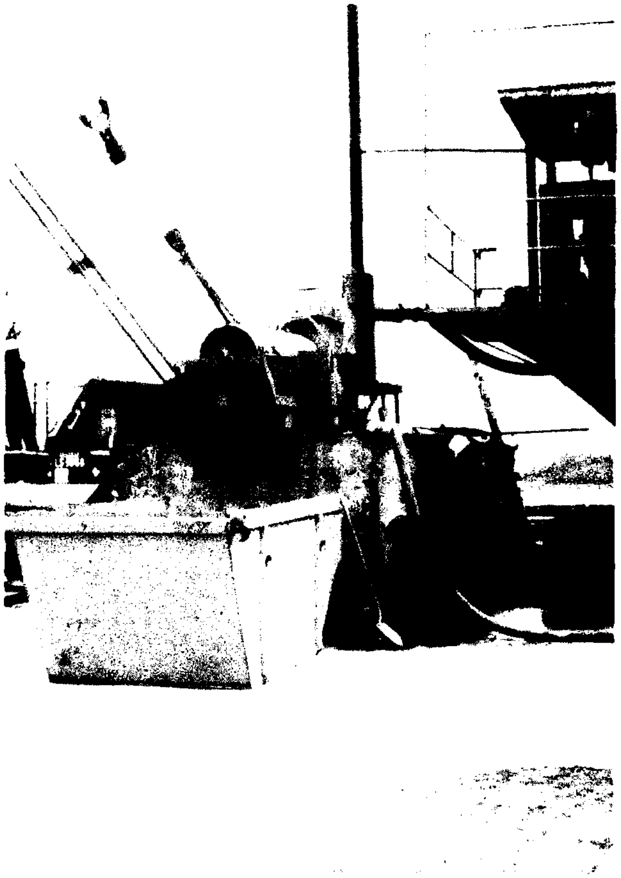
31. Emergency pop off valves, pressure gauge, and emergency shut off for air lift operations.



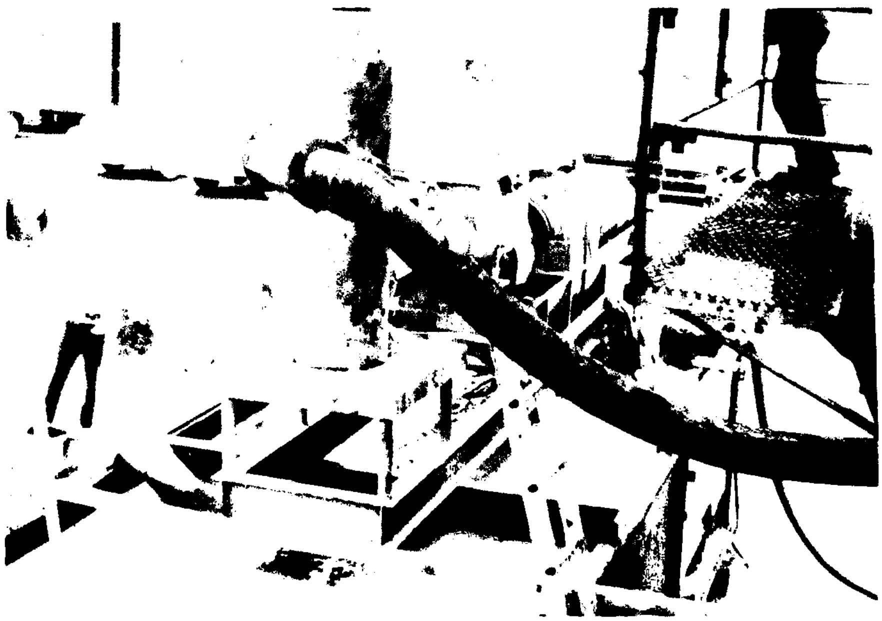
32. Drill string stabilizer assembly in casings.



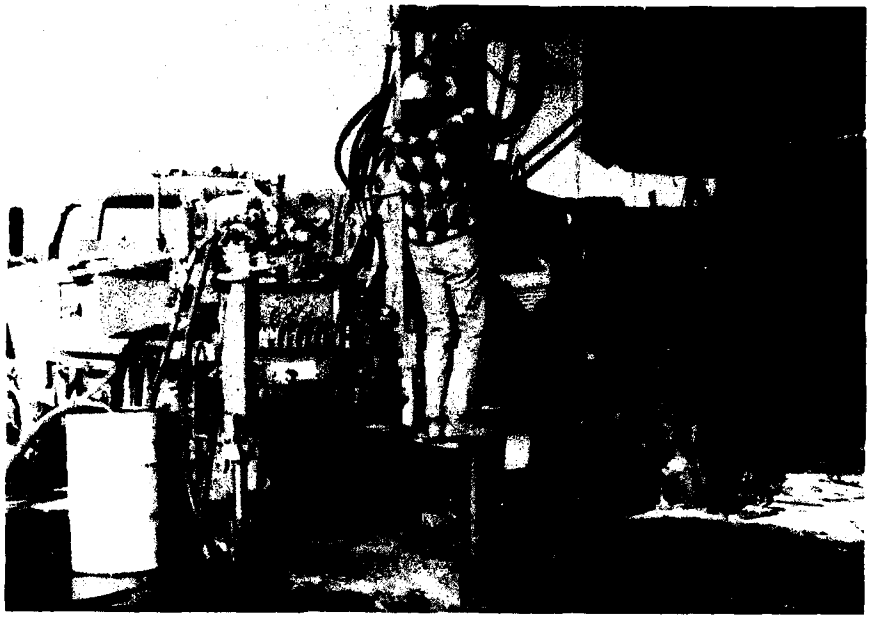
33. Drilling in casing, note gravity return.



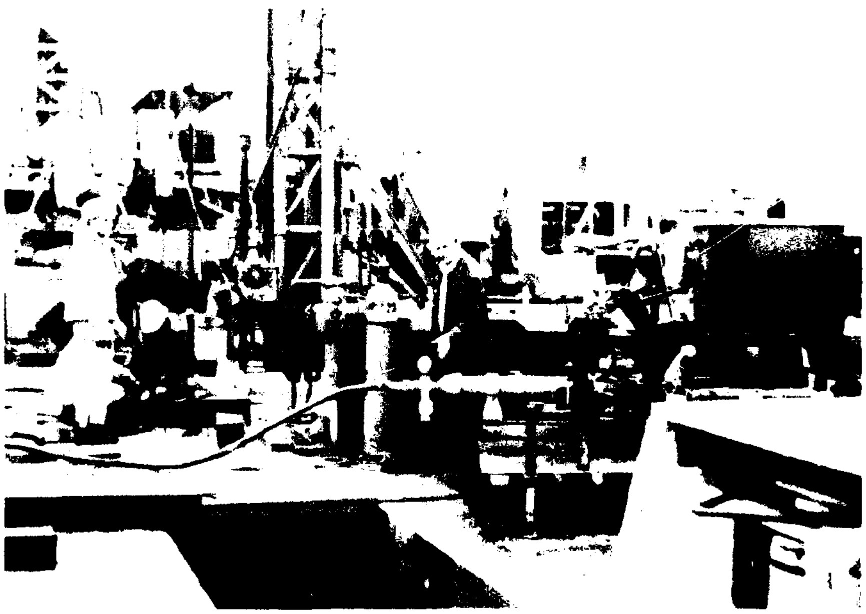
34. Slurry tank with shale shaker for rock drilling operations - front view.



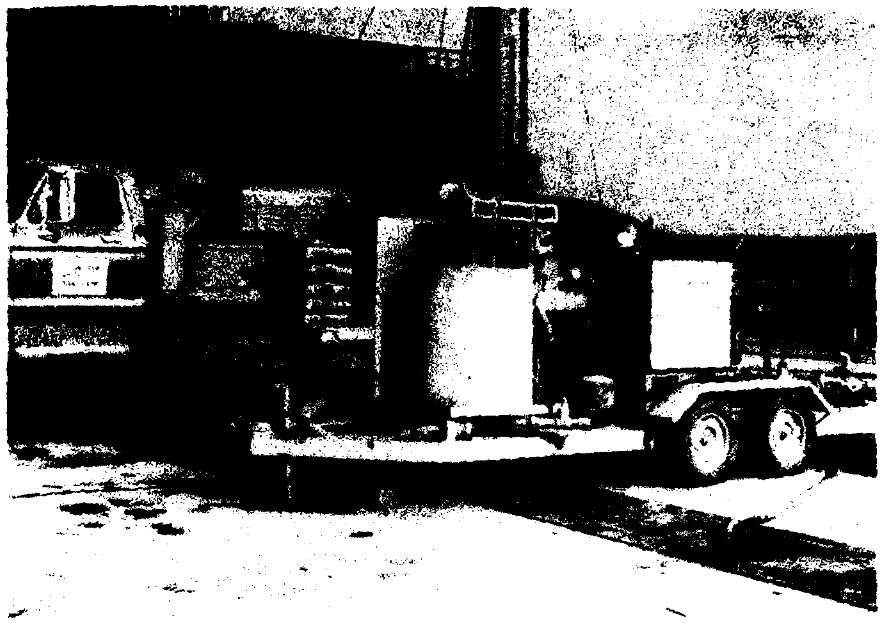
35. Rear view, in operation.



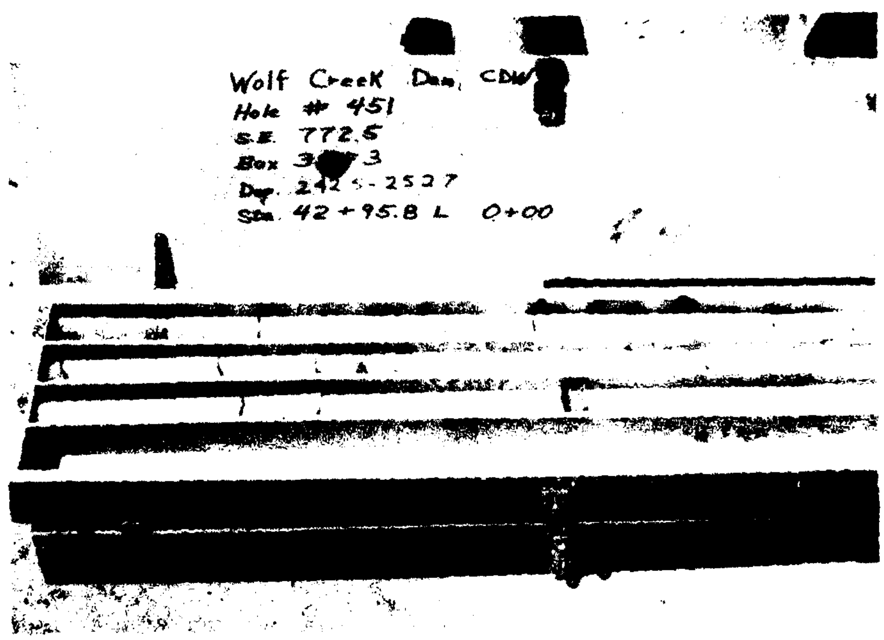
36. NQ core drilling after large hole drilling comp. to grade. Mobile B-53 drill rig used.



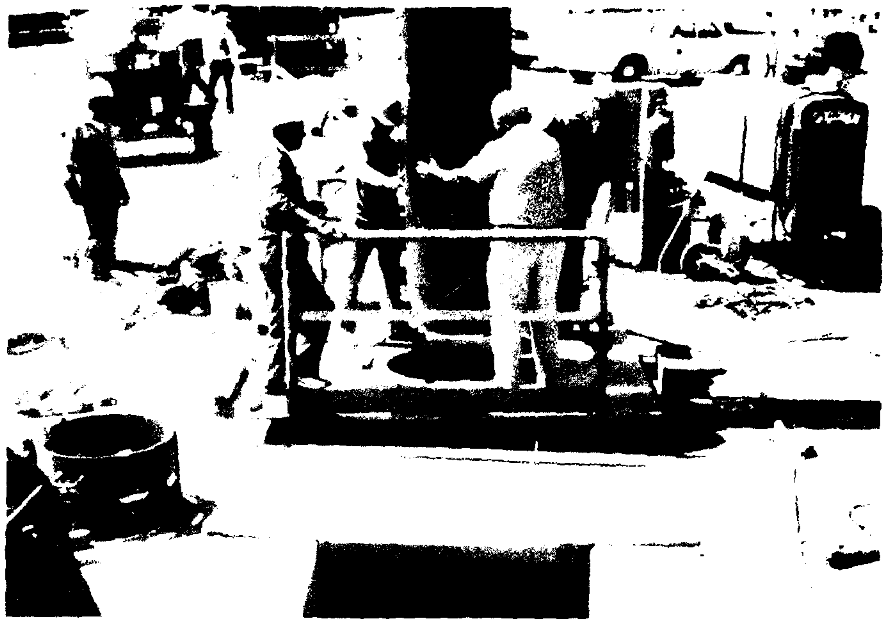
37. Each core hole pressure tested...



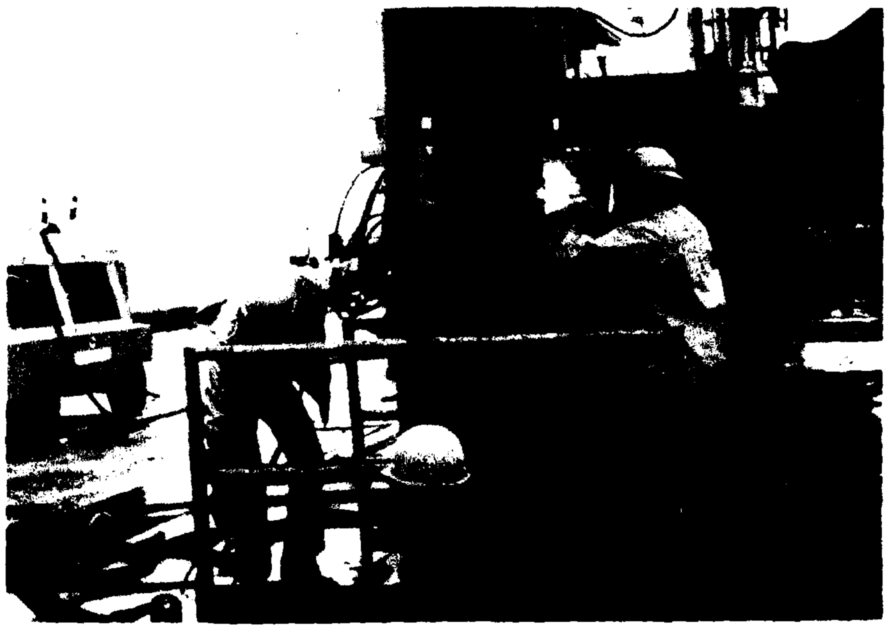
38. ...and pressure grouted.



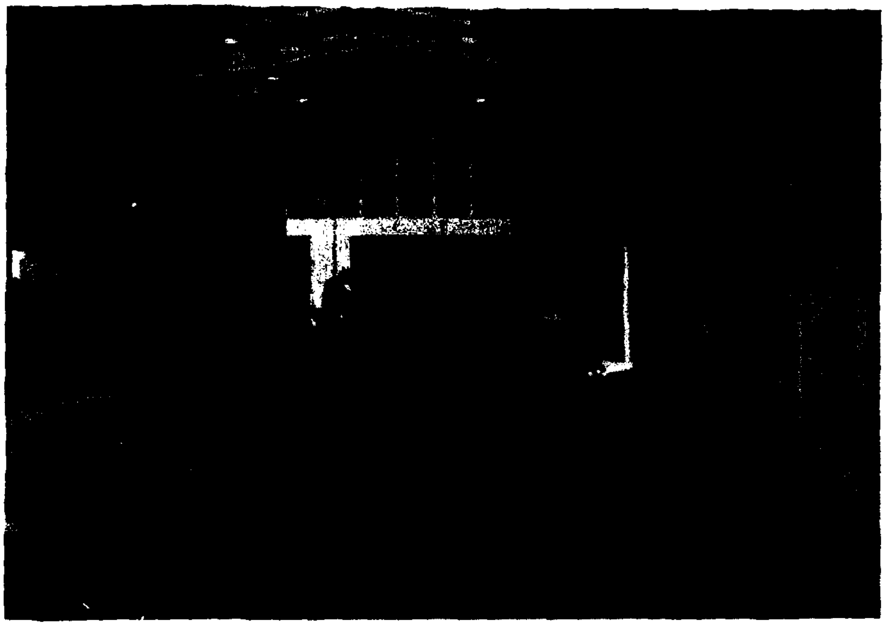
39. Example of limestone core obtained below grade. Elements deepened if any weathering observed.



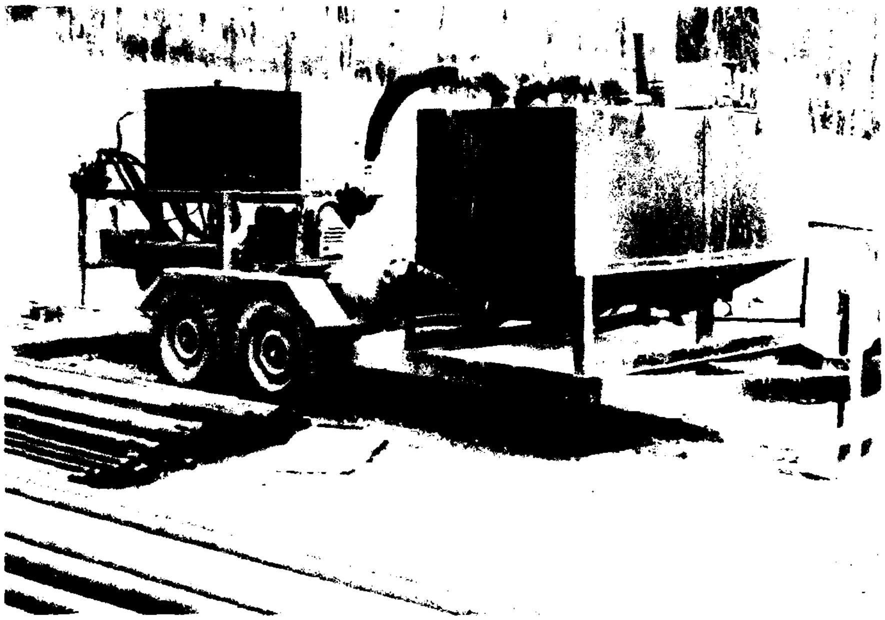
40. Bottom closed section of 26" diameter steel casing inserted in primary element.



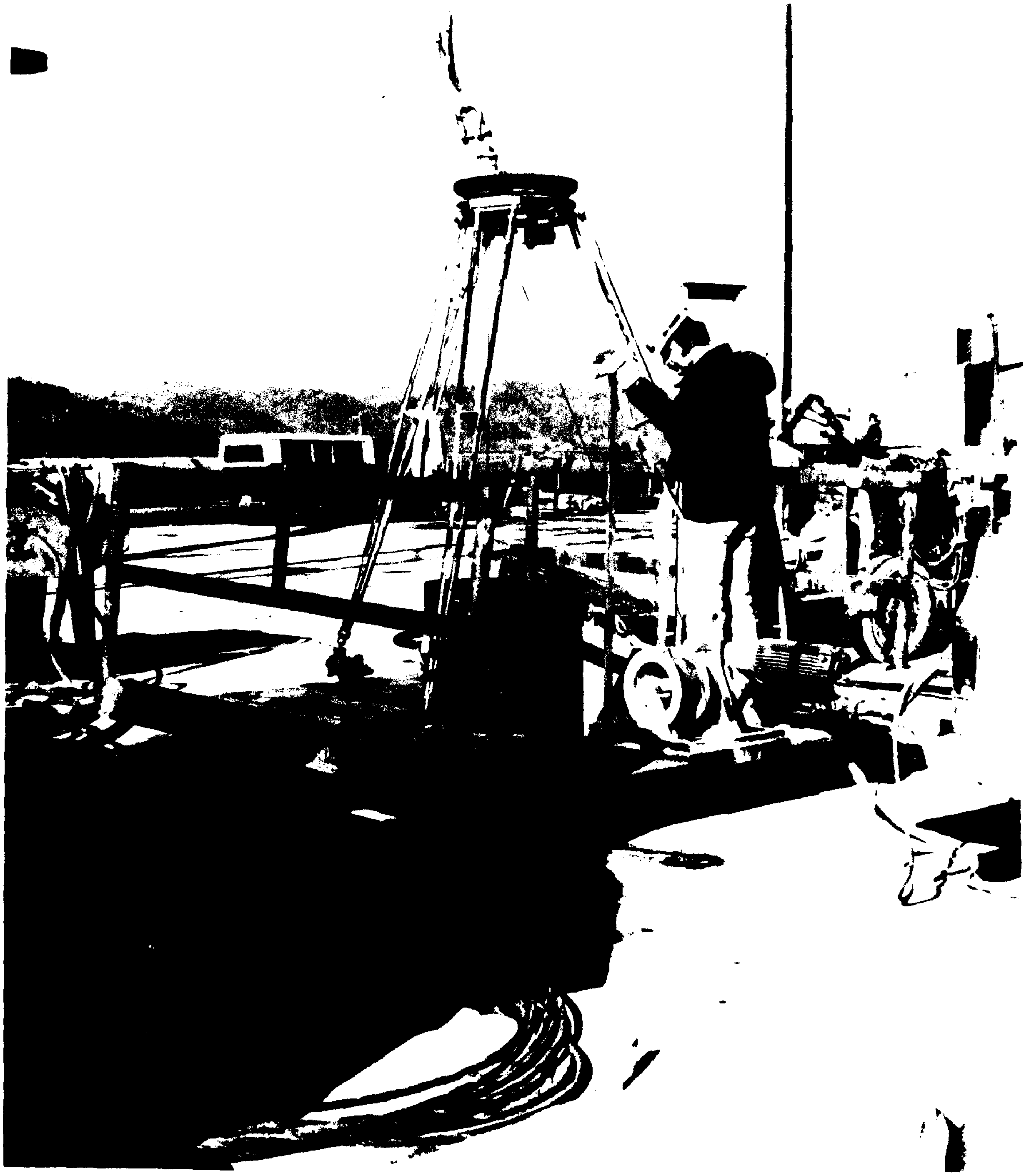
41. Welding sections of 26" permanent casing.



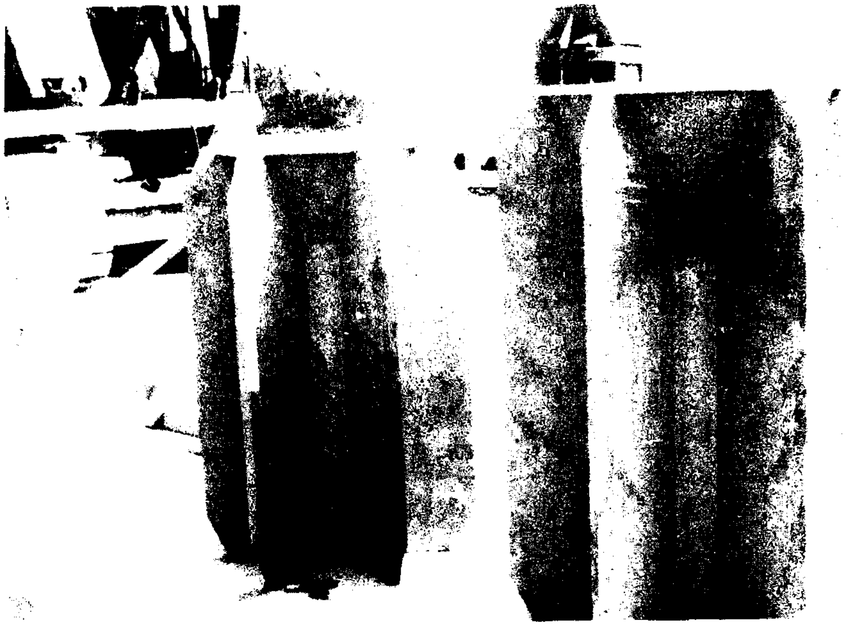
42. Fabricating 26" casing in welding shop.



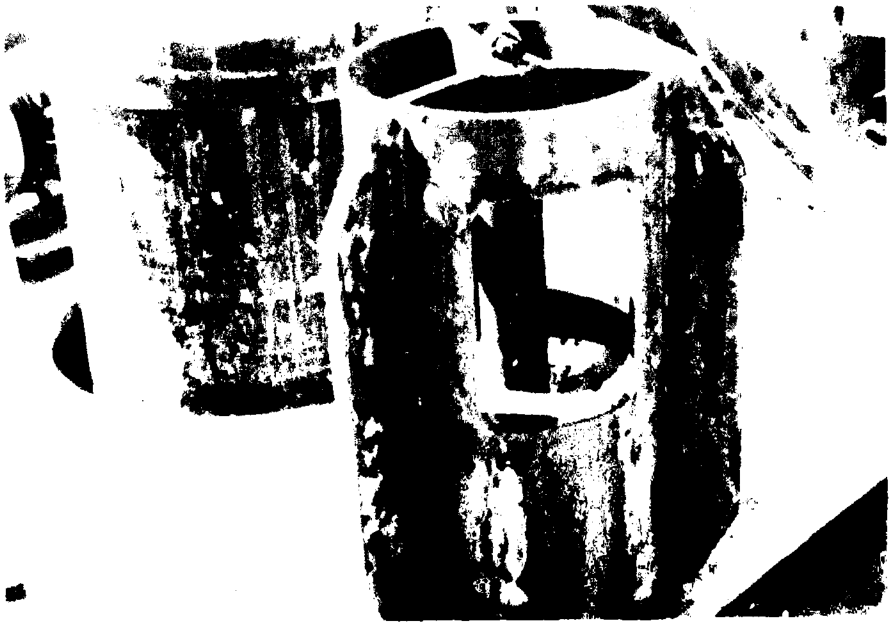
43. Annular space grout plant - filled annulus around 26" casing with low strength cement-bentonite grout.



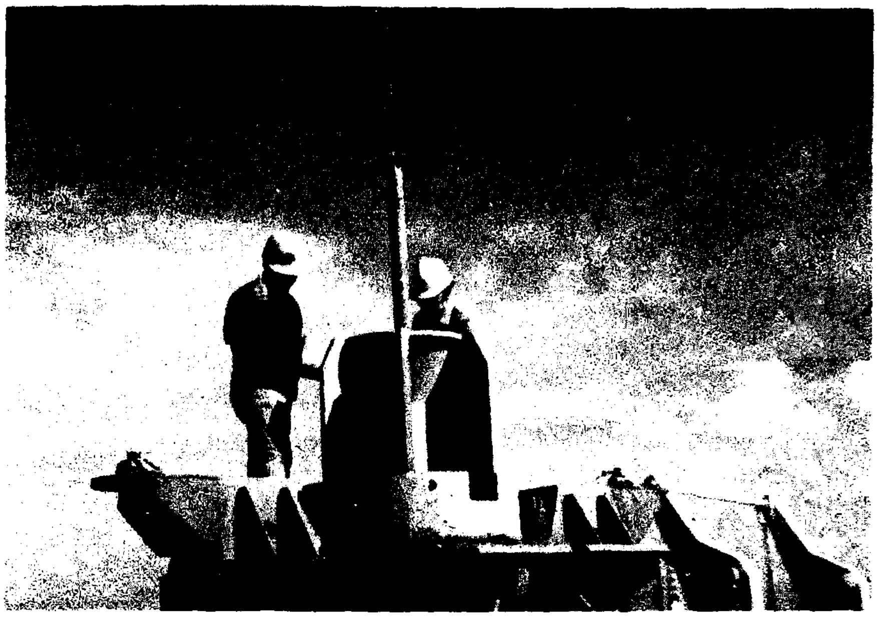
44. Setting up for final verticality check.



45. Plumb bobs for verticality testing 47" and 41" casings.

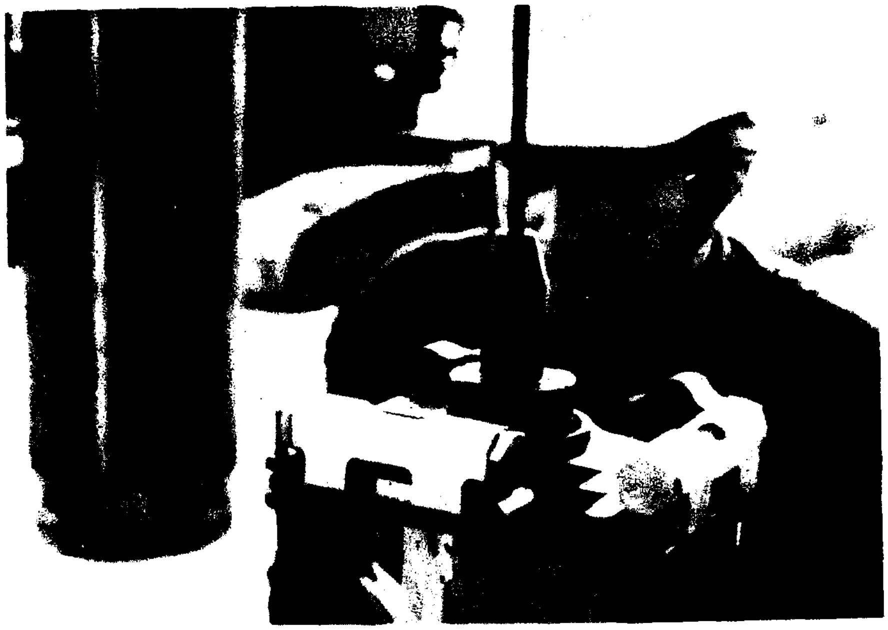


46. Plumb bob. for 26" casing.

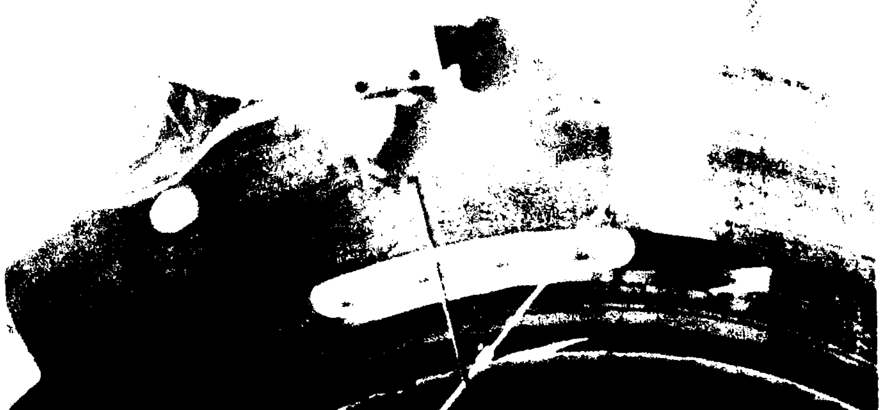


47. Lowering plum bob in hole.

48. Plumbing the line.



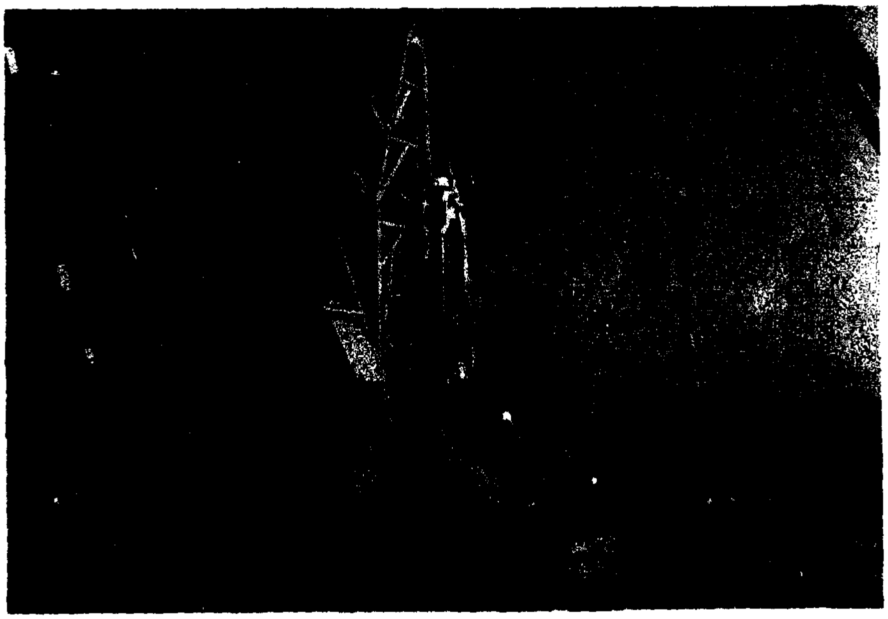
49. Bubble levels used to plumb line.



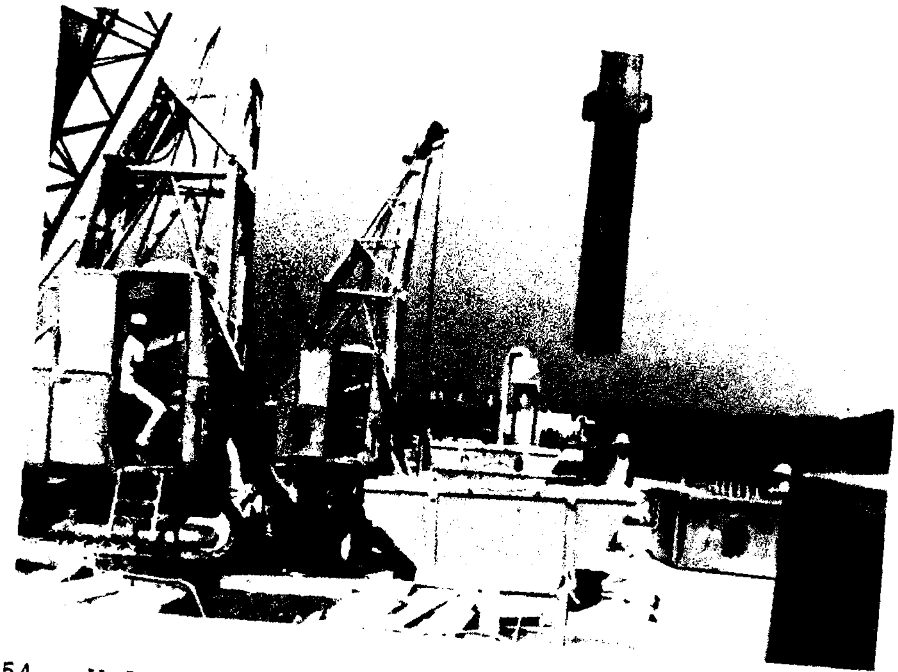
50. Comparing theoretical center with plumbline to measure verticality offset.

51. Secondary excavation.

52. Measuring between 2 primaries to start excavation.

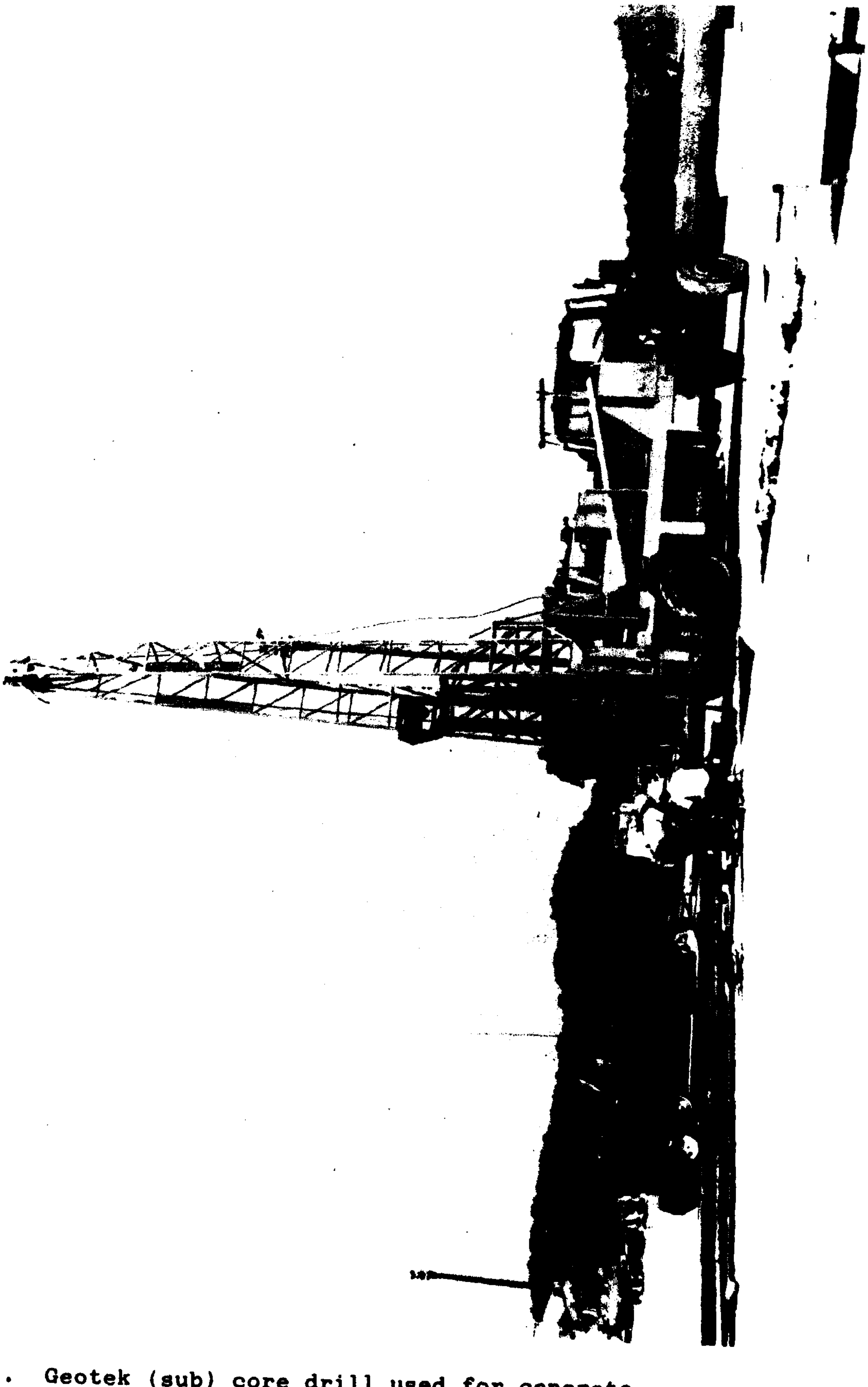


53. Wolf Creek Rig with array of excavation devices - square (side) chisel (on rig), biconcave clam bucket and star chisel (on ground).

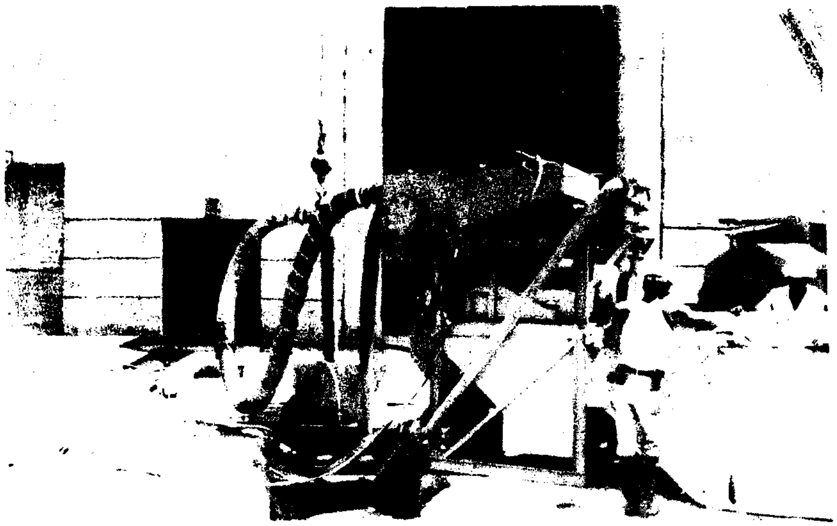


54. Wolf Creek Rigs with bailer.

55. Biconcave chisel guide.



56. Geotek (sub) core drill used for concrete coring.

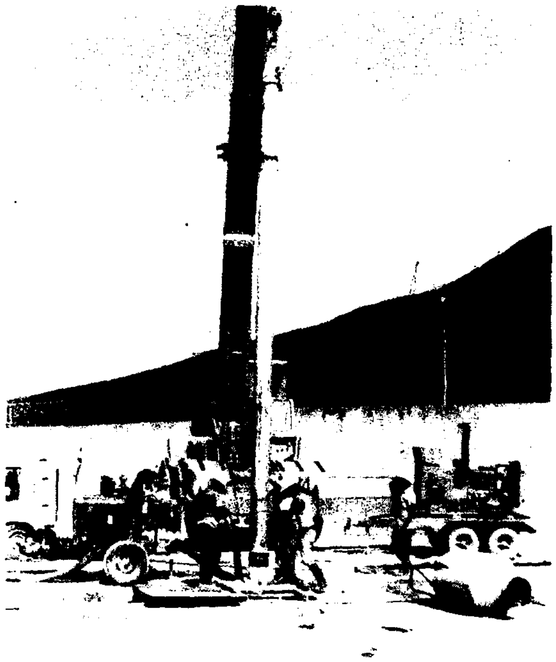


57. Secondary elements were desanded before concrete placement.

58. Typical concrete placement.

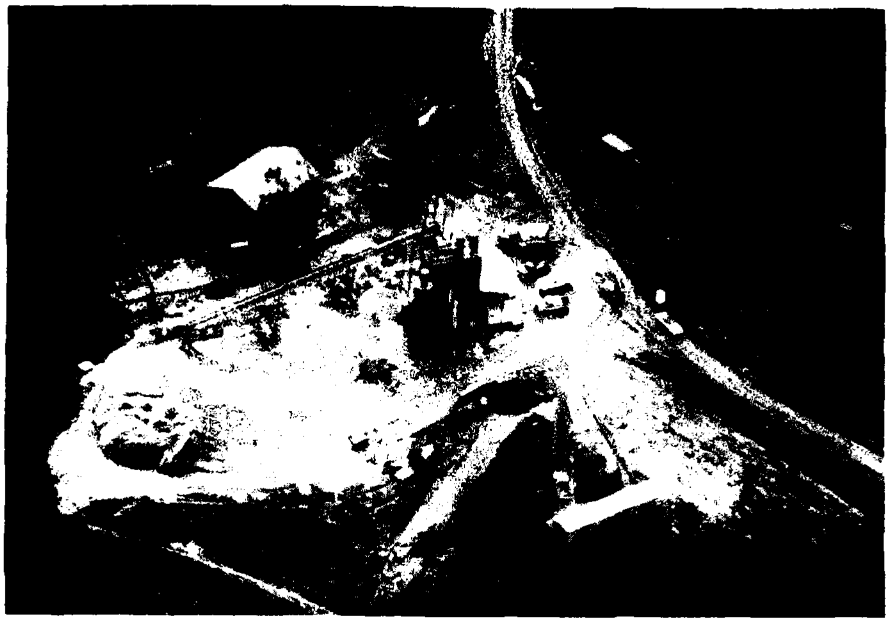
59. Basketball in hopper prior to concrete placement.

60. Wooden sphere replaced basketball as retrievable travelling plug.



61. Pulling tremie pipe.

62. Centering fins added to tremie pipe to improve concrete quality in primary elements.

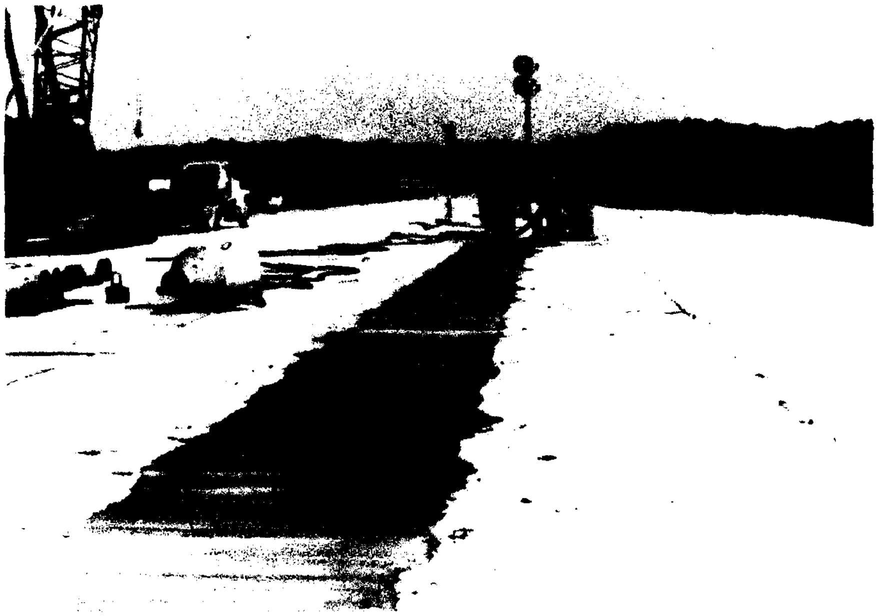


63. Batch plant.

64. Completed section of wall.

65. General activity on work platform.

66. General array of construction activities.



67. Patch over wall during site restoration.

APPENDIX F

BID SCHEDULE/ACTUAL PERFORMANCE COMPARISON

WOLF CREEK DAM
CONCRETE DIAPHRAGM WALL
PHASE I-CONTRACT NO. DACW62-75-C-0206
BID SCHEDULE/ACTUAL PERFORMANCE COMPARISON

ITEM NO	DESCRIPTION	CONTRACT QUANTITY AND UNIT	UNIT PRICE	CONTRACT AMOUNT	ACTUAL QUANTITY AND UNIT	ACTUAL AMOUNT
1.	Mobilization and Demobilization	Lump Sum	xxx	$5,000,200.00	Lump Sum	$5,000,200.00
2.	Site Preparation	Lump Sum	xxx	$5,150,000.00	Lump Sum	$5,150,000.00
3.	Traffic Control	33 Months	$10,000.00	$330,000.00	33 Months	$330,000.00
4.	Embankment Concrete Diaphragm Wall in Embankment and Overburden	189,500 S.F.	$75.00	$14,212,500.00	186,288.5 S.F.	$13,971,637.50
5A.	Embankment Concrete Diaphragm Wall in Bedrock, Centerline Element P-113 to Centerline Element P-181	11,500 S.F.	$400.00	$4,600,000.00	11,620.6 S.F.	$4,648,240.00
5B.	Embankment Concrete Diaphragm Wall in Bedrock, Centerline Element P-181 to Centerline Element P-541	18,000 S.F.	$200.00	$3,600,000.00	19,625.1 S.F.	$3,925,020.00
6.	Switchyard Concrete Diaphragm Wall in Embankment and Overburden	23,500 S.F.	$50.00	$1,175,000.00	21,766.7 S.F.	$1,088,335.00
7.	Switchyard Concrete Diaphragm Wall in Bedrock	24,700 S.F.	$360.00	$8,892,000.00	25,282.5 S.F.	$9,101,700.00
8.	Concrete Backfill for Stabilizing Fluid Losses in Rock	1,500 C.Y.	$300.00	$450,000.00	0.00	$0.00
9.	Tie-In to existing Concrete Dam	Lump Sum	xxx	$2,500,000.00	Lump Sum	$2,500,000.00
10.	Tie-In to Existing Powerhouse	Lump Sum	xxx	$1,000,000.00	Lump Sum	$1,000,000.00
11.	Foundation Drilling and Grouting					
	a. Mobilization and Demobilization	Lump Sum	xxx	$400,000.00	Lump Sum	$400,000.00
	b. Portland Cement in Grout	6,800 C.F.	$10.00	$68,000.00	1,244.0	$12,440.00
	c. Mineral Filler in Grout	350 C.F.	$10.00	$3,500.00	0.0	$0.00
	d. Sand in Grout	1,000 C.F.	$5.00	$5,000.00	0.0	$0.00
	e. Clay in Grout	350 C.F.	$10.00	$3,500.00	0.0	$0.00

	F. Placing Grout	8,500 C.F.	$20.00	$170,000.00	724.69 C.F.	$14,493.80
	g. Connections to Grout Holes	400 Ea.	$8.00	$3,200.00	694 Ea.	$5,552.00
	h. Drilling Exploratory Core Holes, NQ Size-Vertical	10,800 L.F.	$40.00	$432,000.00	11,068.7 L.F.	$442,748.00
	i. Pressure Testing (Hydraulic)	150 Hours	$200.00	$30,000.00	112.67 Hours	$22,534.00
12.	Instrumentation	Lump Sum	xxx	$200,000.00	lump Sum	$200,000.00
13.	Stone Protection, Bedding Layer	6,500 C.Y.	$20.00	$130,000.00	3,478.08 C.Y.	$69,561.60
14.	Stone Protection, Riprap	19,500 C.Y.	$40.00	$780,000.00	13,332.12 C.Y.	$533,284.80
15.	Warehousing and Racks, Core Storage (increased by Mod P00002)	Lump Sum	xxx	$150,000.00 ($158,237.87)	Lump Sum	$158,237.87
16.	Reset Drill	15 Ea.	$5,000.00	$75,000.00	1 Ea.	$5,000.00
17.	Test Drilling and Backfilling Concrete Elements	6,000 L.F.	$100.00	$600,000.00	6,900.00 L.F.	$690,000.00
18.	(added by Mod P00005) Wall Anchor Jacking Tests	Lump Sum	xxx	$26,400.00	Lump Sum	$26,400.00
19.	(added by Mod P00006) Work Platform Security Fence	Lump Sum	xxx	$21,100.00	Lump Sum	$21,100.00
20.	(added by Mod P00007) Nondomestic Steel Pipe Credit	Lump Sum	xxx	(-)$282,000.00	Lump Sum	(-)$282,000.00
21.	(added by Mod P00009) Widening of Existing Powerhouse and Resident Engineer's Office Access Roads	Lump Sum	xxx	$24,836.00	Lump Sum	$24,836.00
22.	(added by Mod P00010) Electronic Transducer and Pneumatic Piezometer Monitoring System	Lump Sum	xxx	$222,895.65	Lump Sum	$222,895.65
23.	(added by Mod P00011) Extension of Core Storage Building	Lump Sum	xxx	$23,702.70	Lump Sum	$23,702.70
24.	(added By Mod P00012) 8 Inch Tremie	Lump Sum	xxx	$33,183.12	Lump Sum	$33,183.12
25.	(added by Mod (00013) Repair of Access Roadway, Corps of Engineers Facilities	Lump Sum	xxx	$2,500.00	Lump Sum	$2,500.00
26.	(added by Mod P00014) Temporary Stairway for Platform	Lump Sum	xxx	$16,543.76	Lump Sum	$16,543.76
27.	(added by Mod P00015) Accelerated Construction of Elements					

	S-170, S-176, and S-180	Lump Sum	xxx	$25,242.10	Lump Sum	$25,242.10
28.	(added by Mod P00017) Air Lift Credit	Lump Sum	xxx	(-)$75,000.00	Lump Sum	(-)$75,000.00
29.	(added by Mod P00018) Replacement of Guardrail	Lump Sum	xxx	$31,600.00	Lump Sum	$31,600.00
30.	(added by Mod P00019) Resurfacing No. 2 Dam Adit Road	Lump Sum	xxx	$14,994.78	Lump Sum	$14,994.78
31.	(added by Mod P00021) Overrun in Item No. 17, Concrete Test Drilling	Lump Sum	xxx	$155,054.50	Lump Sum	$155,054.50
32.	(added by Mod P00021) Recovery of Fixed Cost Associated with Underruns of Items Nos. 8 & 16	Lump Sum	xxx	$326,750.00	Lump Sum	$326,750.00
33.	(added by Mod P00022) Underrun Adjustment for Item Nos. 13 & 14	Lump Sum	xxx	$50,000.00	Lump Sum	$50,000.00
		Total Contract with revisions due to change orders and overruns:		$51,372,000.48		
		Revisions due to underruns:		$1,385,213.30		
		Total:		$49,886,787.18	Total:	$49,886,787.18

WOLF CREEK DAM
CONCRETE DIAPHRAGM WALL
PHASE II-CONTRACT NO. DACW62-77-C-0129
BID SCHEDULE/ACTUAL PERFORMANCE COMPARISON

ITEM NO	DESCRIPTION	CONTRACT QUANTITY AND UNIT	UNIT PRICE	CONTRACT AMOUNT	ACTUAL QUANTITY AND UNIT	ACTUAL AMOUNT
1.	Mobilization and Demobilization	Lump Sum	xxx	$2,950,000.00	Lump Sum	$2,950,000.00
2.	Site Preparation	Lump Sum	xxx	$5,677,500.00	Lump Sum	$5,677,500.00
3.	Traffic Control	40 Months	$10,000.00	$400,000.00	36.26 Months	$362,580.65
4.	Concrete Diaphragm Wall, Embankment	211,500 S.F.	$95.00	$20,092,500.00	208,999.56	$19,854,960.10
5A.	Concrete Diaphragm Wall, Rock	36,200 S.F.	$200.00	$7,240,000.00	37,082.70 S.F.	$7,416,540.00
5B.	Concrete Diaphragm Wall, Rock, Elements P-853 thru P-915	13,500.00 S.F.	$600.00	$8,100,000.00	13,847.40 S.F.	$8,308,440.00
6.	Concrete Backfill in Rock	300 C.Y.	$100.00	$30,000.00	0.00	$0.00
7.	Foundation Drilling and Grouting					
7A.	Mobilization and Demobilization	Lump Sum	xxx	$300,000.00	Lump Sum	$300,000.00
7B.	Portland Cement in Grout	2,000 C.F.	$5.00	$10,000.00	893 C.F.	$4,465.00
7C.	Mineral Filler in Grout	50 C.F.	$5.00	$250.00	0.00	$0.00
7D.	Sand in Grout	100 C.F.	$5.00	$500.00	0.00	$0.00
7E.	Clay in Grout	50 C.F.	$5.00	$250.00	0.00	$0.00
7F.	Placing Grout	2,200 C.F.	$6.00	$13,200.00	615 C.F.	$3,690.00
7G.	Conn. to Grout Holes	300 Ea.	$8.00	$2,400.00	557 Ea.	$4,456.00
7H.	Drill Exploratory Core Holes	7,000 L.F.	$70.00	$490,000.00	6,953.2 L.F.	$486,724.00
7I.	Pressure Testing Exploratory Holes	100 Hours	$500.00	$50,000.00	42.92 Hours	$21,460.00
8.	Instrumentation	Lump Sum	xxx	$200,000.00	Lump Sum	$200,000.00
9.	Stone Protection, Bedding Layer	4,500 C.Y.	$20.00	$90,000.00	3,318.00 C.Y.	$66,360.00
10.	Stone Protection, Rip-Rap	13,000 C.Y.	$20.00	$260,000.00	13,659.00 C.Y.	$273,180.00
11.	Reset Drill	10 Ea.	$5,000.00	$50,000.00	1 Ea.	$5,000.00
12.	Test Drilling and Backfilling Concrete Elements	5,000 L.F.	$100.00	$500,000.00	4,487.9 L.F.	$448,790.00
13.	Exploratory Drilling at Element P-1097	Lump Sum	xxx	$21,606.29	Lump Sum	$21,606.29
14.	Coring, Press. Test, Grouting & Backfill Elements S-974 & S-976, Elev. 610 to 590	Lump Dum	xxx	$4,662.59	Lump Sum	$4,662.59
15.	Additional Mobilization	2 Ea.	$1,319.23	$2,638.46	0.00	$0.00
16.	Additional Standby	20 Hours	$105.54	$2,110.80	0.00	$0.00
17.	Assitional Coring, Press. Test, Grouting & Backfilling Elements S-974 & S-976	70 L.F.	$65.96	$4,617.20	0.00	$0.00
18.	Surfacing Upstream Access Road	Lump Sum	xxx	$26,463.36	Lump Sum	$26,463.36
19.	Deletion of Site Restoration Items	Lump Sum	xxx	$23,600.00	Lump Sum	$23,600.00
20.	Underrun Adjustment for Items 6,9,11.	Lump Sum	xxx	$40,000.00	Lump Sum	$40,000.00
21.	Purchase of Office Trailers,(Mod. 11)	Lump Sum	xxx	$12,000.00	Lump Sum	$12,000.00
		Total		$46,594,298.70		
		Revisions Due to Known Overruns and underruns		-$81,820.71		
		Total Contract		$46,512,477.99	Total Amount	$46,512,477.99